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INSTRUCTION FOR USE OF THE DESADE CABLE ARRAYS STATIC  
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COMHANT WASHINGTON DC CHESAPEAKE DIV H SMH SEP 77  
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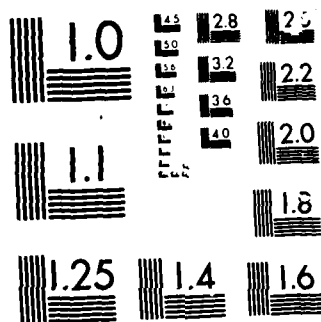
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INSTRUCTION FOR USE OF THE  
DESADE  
CABLE ARRAYS STATIC DEFLECTION PROGRAM

H. SHIH

SEPTEMBER 1977

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This note describes the use of the DESADE program version presently running on the CDC 6600 through the FPO-1 computer terminal. A tri-moor cable array structure is given here as an example to illustrate the procedures in using this program. The original manual on which this note is based was (Con't)

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prepared by R.A. Skop. and J. mark of Naval Research Laboratory, Washington, D.C.

The program calculates the current - induced static deflections of structural cable arrays. Attached to this note are results of test runs made for the Linear Chari candidate configurations. This was designed to serve as a check for the on going Linear Chair analysis contract with DTNSRDC using the DSSM program.

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# ABSTRACT

This note describes the use of the DESADE program version presently running on the CDC 6600 through the FPO-1 computer terminal. A tri-moor cable array structure is given here as an example to illustrate the procedures in using this program. The original manual on which this note is based was prepared by R. A. Skop and J. Mark of Naval Research Laboratory, Washington, D. C.

The program calculates the current - induced static deflections of structural cable arrays. Attached to this note are results of test runs made for the Linear Chair candidate configurations. This was designed to serve as an check for the on going Linear Chair analysis contract with DTNSRDC using the DSSM program.



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## 1. Note of the program

- |              |  |
|--------------|--|
| Usefulness   | 0 computing current - induced static deflections of structural cable arrays.   |
|              | 0 Most general (Ref. 1)  |
|              | 0 Experimentally validated (Ref. 3)  |
| Method       | 0 Use Method of imaginary reactions (Ref. 4) and method of successive approximations for treating position and configuration dependent forces (Ref. 5) |
| Assumptions  | 0 The hydrodynamic force on the devices and cables is the normal drag.   |
|              | 0 The current is unidirectional and horizontal (with certain modification it could accept arbitrary current field with variable directions).           |
| Capabilities | 0 arbitrarily configured arrays of up to 22 cables   |
|              | 0 variable cable materials   |
|              | 0 any number of discrete devices   |
| Limitations  | 0 Cable segments cannot be on the ocean floor.   |
|              | 0 Dimensions of discrete device must be small compared to overall array dimensions (not valid for moored submerged submarine.)                         |
|              | 0 All parts of the array must be submerged (unless the surfaced device coordinates are specified),   |

## 2. Array description

EXAMPLE : A sea spider (tri-moor) array structure is used here to illustrate the steps required for in preparing array structure input data. The array design is sketched in Figure 1. It is intended to calculate the static deflections and the forces of each structural member under hydrodynamic loading of an ocean current (Figure 2.)

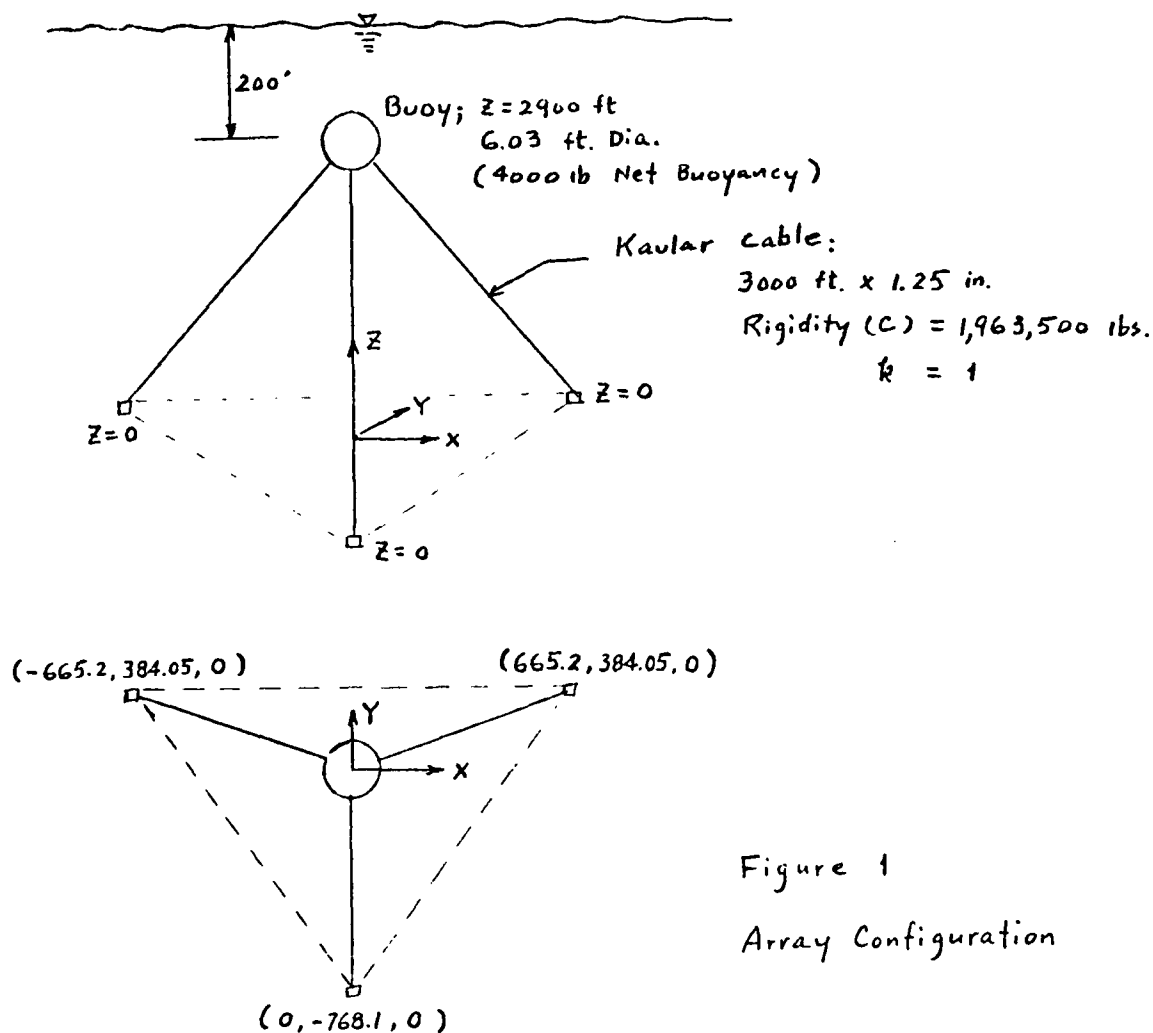


Figure 1  
Array Configuration

## STEPS

- a. Number the cables consecutively from one to the total number of cables in the array. Each cable so designed must have uniform properties (weight, diameter, drag coefficient, and constitutive relation). A change in property also requires a change in cable number.
- b. Number the junctions consecutively from one to the total number of junctions in the array. A junction may designate an anchor, the intersection point of two or more cables, the free end of a cable.
- c. Use a fixed, right-hand cartesian coordinate system to describe the configuration of the array in the space. The origin of the system can be arbitrarily located. Z axis is defined parallel to the direction of gravity and increasing upward. In this example the origin is placed at the geometric center of the equilateral triangle formed by the three anchors in the sea floor plan.
- d. Tabulate the anchor coordinates (Table 1.)

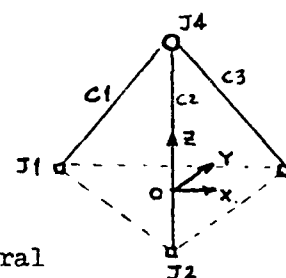
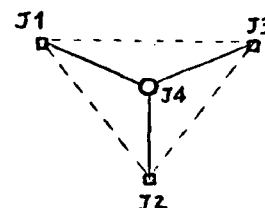
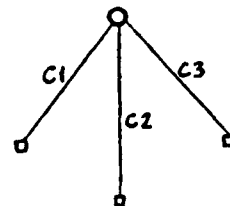


Table 1

Junction No. of anchor	Anchor coordinates		
	X (ft)	Y (ft)	Z (ft)
1	-665.2	384.05	0
2	0	-768.1	0
3	665.2	384.05	0

e. Reduce the array to statically determinate array structure. The cuts are made in the following manner:

1. Number of cuts = number of cables + number of anchors - number of junctions
2. Cuts must be made at end points of cables (adjacent to junctions).
3. The first group of cuts must be made so as to release all but one cable from an anchor.
4. The remaining required cuts are made within the array and must be located so as not to break the array into separated parts.
5. Assign each new cut a consecutive junction number continuing from the last-used junction number.
6. Tabulate the junction number

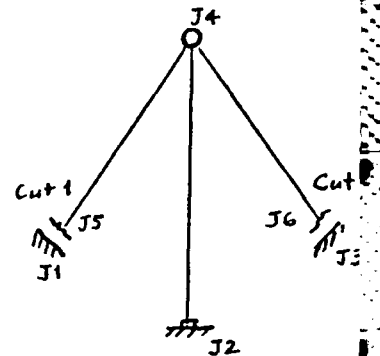
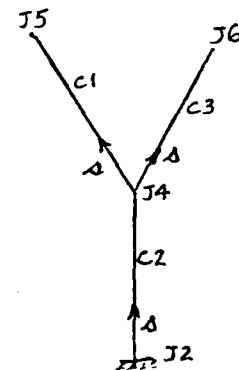


Table 2

Cut number	Original Junction Number at cut	New Junction Number at cut
1	1	5
2	3	6

7. Define the directions of increasing arc length, (s), along each cable by using a topological tree diagram for the reduced array structure (see sketch). The directions are indicated by the arrowheads in the climbing 'up' direction from root to top.



8. Following the directions given in step 7 tabulate the junction number of the starting ( $s=0$ ) and ending ( $s=L$ ) points for each cable (Table 3).

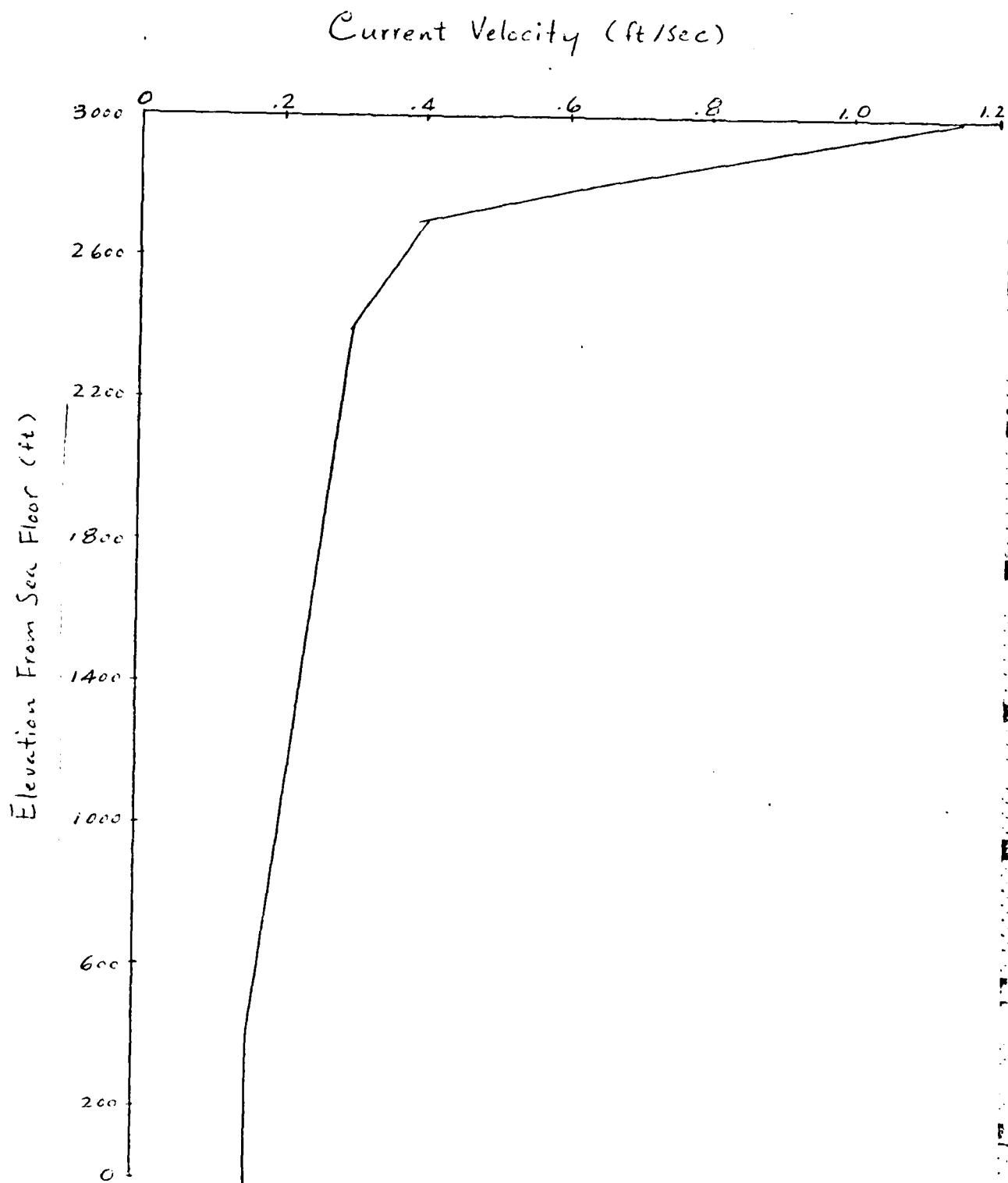


Figure 2 Current Profile in St Croix

Table 3

Cable number	Junction number at s=0	Junction number at s=L
1	4	5
2	2	4
3	4	6

The starting and ending points of each cable can be identified by following the direction of 'climbing up' the topological tree diagram. s is the arc length measured from starting junction. L is the length of each cable.

### 3. Current description

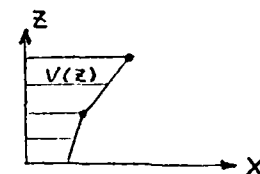
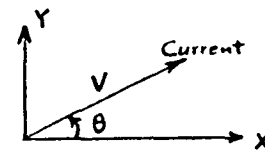
The standard current field is defined as

$$V = V(z) (\cos \theta \hat{i} + \sin \theta \hat{j})$$

where  $v(z)$  = current value at  $z$ .

$\theta$  = current angle with respect to x axis

$\hat{i}, \hat{j}$  = unit vectors in the x and y axes



The program generates the velocity profile by connecting each current data point by a series of straight lines. The current below the minimum z value is considered the same as  $V(z\text{-minimum})$ . Using the current profile given in Figure 2 the input current data can be tabulated (Table 4.)

Table 4

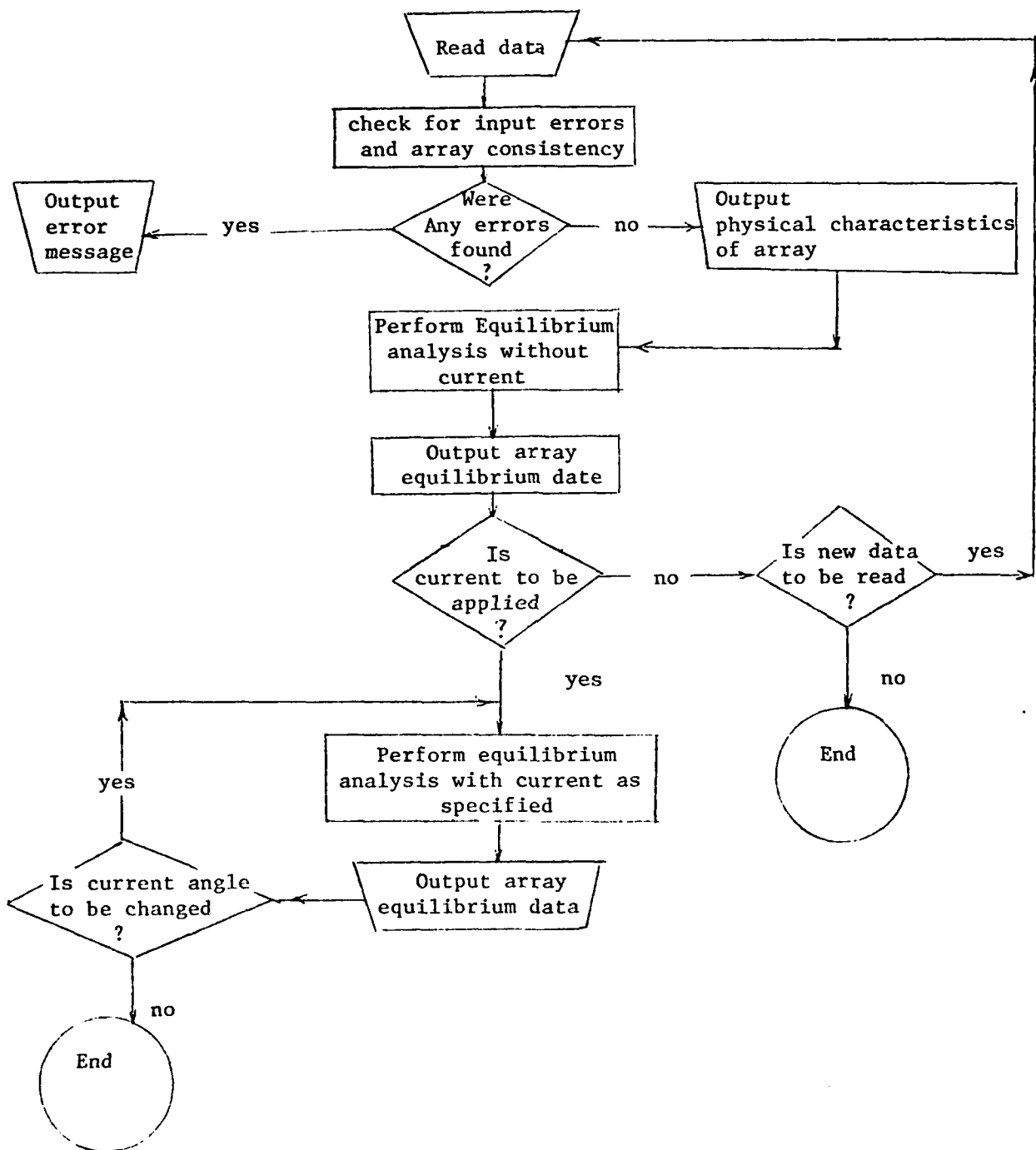
Z Coordinate (ft)	V (Z) (Knots)
0	.1
400	.1
2400	.18
2700	.24
2900	.53

#### 4. Program Structure

In addition to the main program 'DESADE' there are 8 subroutines and 7 functions. These are described below:

Subroutines	Purpose
INPUT	Reads all data and identifies errors in data, deck structure, and array representation.
PHSOUT	Generates information concerning the physical characteristics of the structural cable array.
STROUT	Generates the array structural output.
TAPOUT	Generates the tape or cards giving the locations of the indexed devices.
ERROR	Generates error message when the accuracy required for the array equilibrium calculation could not be obtained.
RPOLY	Finds real roots of polynomial equations for use in evaluating maximum cable displacements and tension extreme.
SWITCH	Switches input data.
START	Calculates the initial guesses.
Functions	Purpose
TCAB(M,K)	Calculates the tension at node M of Cable K.
EXCAB(M,K)	Calculates (1 + strain) at node M of Cable K.
EFORCE (I)	Calculates the hydrodynamic drag force on each device in direction I.
CFORCE (I,M,N)	Calculates the force/length in direction I at node M on Cable N.
SPACE (I)	Calculates the location in space of any point on the array.
TANG (I)	Calculates the unit tangent to a cable at any point.
VELOC (I,P SPACE)	Specifies the I component of the current field at an arbitrary point in space, PSPACE (I).

## 5. Program Flow Chart





## 6. Input Coding

### (1) I/O logical unit number card

Column	1	4	8	16	24	32	40	48	56	64
	Ncard	Card	Nread	Nwrite	Ntape	Iopt.	Blank	Mopt.	Kopt.	

Ncard = card number, (I4), From - 999 to 9999, used to sequence the data cards

Card = LUN, (A4), used to catalog each data card

Nread = 5, (I8), reader unit number

Nwrite = 6, (I8), printer unit number

Ntape = 2, (I8), service tape unit number

Iopt. = 0, (I8), Input option using source deck

Mopt. = 2 or 0, (I8), Output option to printer

Kopt. = 3 or blank, (I8), Output tape unit number

### (2) number card of junctions

1	4	8	16
Ncard	Card	Njun.	

Card = Njun., (A4), card name

Njun. = number of junction in original Array, (I8)

(See Figure 1),  $2 \leq N_{Jun} \leq 44$

### (3) Anchor location cards (one for each anchor)

1	4	8	16	24	32	40
Ncard	Card	Njun	X	Y	Z	

Card = ANC, (A4)

Njun. = Junction number of anchor (original array)

$1 \leq N_{Jun} \leq 44$ , (I8)

X = anchor X - coordinate (ft.), (F8.0)

Y = anchor Y - coordinate (ft.), (F8.0)

Z = anchor Z - coordinate (ft.), (F8.0)

Refer to Table 1.

(4) Cut data cards (one for each cut)

1	4	8	16	24
Ncard	Card	NJun,New	NJun,Old	

Card =  $\sim \sim$  IR, (A4)

NJun,New = New junction number at cut, (I8)

NJun.Old = Orginial junction number at cut, (I8)

$$1 \leq \text{NJun,Old} \leq 44$$

Refer to Table 2.

(5) Cable cards (one for each cable)

1	4	8	16	24	32	40	48	56	64	72	77	80
Ncard	Card	N <sub>C</sub>	NJun. <sub>s=0</sub>	NJun. <sub>s=L</sub>	W <sub>C</sub>	CD <sub>C</sub>	d	L	C	h	N <sub>ele.</sub>	

Card =  $\sim$  CAB, (A4)

N<sub>C</sub> = cable number; (I8),  $1 \leq N_C \leq 22$

NJun,s=0 = Junction number at s=0, (I8),  $1 \leq N \leq 44$

NJun,s=L = Junction number at s=L, (I8),  $1 \leq N \leq 44$

W<sub>C</sub> = cable unit weight in sea water (lb/ft), (F8.0)

(+) if positively buoyant

(-) if negatively buoyant

CD<sub>C</sub> = cable normal drag coefficient, (F8.0), (based on cable diameter)

d = cable diameter, (in.), (F8.0)

L = cable unstressed length (ft), (F8.0)

C = cable rigidity (lb), (F8.0)

$(T/C)^k = \epsilon$  , T = tension,  $\epsilon$  = Strain, k = constant

k = constant in cable constitutive relation, (F5.0)

Nele. = number of finite elements in cable calculation, (I3),

$0 < N \leq 50$

(6) Device on cable cards (one for each device)

1	4	8	16	24	32	40	48	56	64	72
N <sub>card</sub>	Card	N <sub>c</sub>	I <sub>type</sub>	Index	W <sub>d</sub>	C <sub>Dd</sub>	A.	1	S <sub>d</sub>	

Card = DCAB, (A4)

N<sub>c</sub> = number of cable to which device is attached, (I8)

$1 \leq N \leq 22$

I<sub>type</sub> = device type, (I8), 1 or 3 for in-line elongated device

(longitudinal axis aligns with cable axis), 2 or 4 for

other free devices or for devices inside the cable.

I<sub>Index</sub> = Device index if type 1 or 2, (I8)  $1 \leq I \leq 1000$ , Type 1 and

2 must be indexed consecutively from one to the total number

of type 1 and 2 devices in the array.

W<sub>d</sub> = device weight in sea water (lb.), (F8.0)

(+) if positively buoyant

(-) if negatively buoyant

C<sub>Dd</sub> = device drag coefficient, (F8.0)

(based on frontal area or diameter)(blank if device is inside

the cable)

A. = Frontal area of device for type 2 or 4 (ft<sup>2</sup>), (F8.0)

or diameter of device for type 1 or 3, (in), (F8.0).

$l$  = device length (if type 1 or 3), (ft), (F8.0).

$S_d$  = Unstressed distance of device from  $s=0$  junction of the cable, (ft), (F8.0).

(7) Device on junction cards (one for each device)

1	4	8	16	24	32	40	48	56
$N_{card}$	Card	$N_{Jun}$	$I_{type}$	$I_{dex}$	$W_d$	$C_{od}$	A.	

Card = DJNC, (A4)

$N_{Jun.}$  = number of junction to which device is attached, (I8)

$$1 \leq N \leq 44$$

$I_{type}$  = Device type (2 or 4), (I8)

$I_{dex}$  = Device index if type 2, (I8)

$1 \leq I \leq 1000$  (indexed consecutively from one to the total number of type 1 and 2 devices in the array.

$W_d$  = Device weight in sea water (lb.) (F8.0)

(+) if positively buoyant

(-) if negatively buoyant

$C_D$  = Device drag coefficient based on frontal area (F8.0)

A. = device frontal area ( $ft^2$ ), (F8.0)

(8) Water density card

1	4	8	16
$N_{card}$	Card	$\rho_f$	

Card = ^DEN, (A4)

$\rho_f$  = sea water density, (slug /  $ft^3$ ), (F8.0)

- (9) End of data card

1	4	8
N <sub>card</sub>	Card	

Card = ^EOD, (A4)

- (10) Flag card to specify current data

1	4	8	16
N <sub>card</sub>	Card	I <sub>opt.current</sub>	

Card = NDAT, (A4)

I<sub>opt. current</sub> = Current option = 1 standard

= 2 nonstandard (use modified program)  
(I8)

- (11) Accuracy card (following the 1st NDAT card)

1	4	8	16
N <sub>card</sub>	Card	E	

Card = COMP, (A4)

E = accuracy specified (ft), (F8.0)

To insure the calculated coordinates of every point in the array are within  $\pm E$  of their exact values. The obtainable  $\bar{E}$  is limited by the computer capacity and by the largest linear dimension in the array.

$\bar{E} \leq 10^{m-n+3}$  where  $m$  = common logarithm of the largest linear dimension,  $n$  = number of significant figures carried in single precision (e.g.  $n = 8$ ,  $L = 25,000$  ft,  $\bar{E} \geq 0.1$  ft.)

$\bar{E} = 1$  ft. was used in the test runs.

- (12) Current cards (one for each point)

1	4	8	16	24
N <sub>card</sub>	Card	Z	V(Z)	

Card = ^VEL, (A4)

$Z = Z$  - coordinate of input point, (ft), (F8.0)

$V(Z)$  = Velocity at input point, (knots), (F8.0)

Up to 25 VEL cards are permitted. At least on input point must be below or equal the minimum  $Z$  coordinate of the anchors.

(13) Current direction card

$\left| \begin{array}{c} 1 \\ N_{\text{card}} \end{array} \right| \begin{array}{c} 4 \\ \text{Card} \end{array} \left| \begin{array}{c} 8 \\ \theta_0 \end{array} \right| \begin{array}{c} 16 \\ \Delta\theta \end{array} \left| \begin{array}{c} 24 \\ \theta_f \end{array} \right| \begin{array}{c} 32 \\ \end{array} \right|$

Card = ^ ANG, (A4)

$\theta_0$  = initial current angle (deg.), (F8.0)

$\Delta\theta$  = increment in current angle (deg. > 0), (F8.)

$\theta_f$  = final current angle (deg.  $\geq \theta_0$ ), (F8.0)

(14) End of data card

$\left| \begin{array}{c} 1 \\ N_{\text{card}} \end{array} \right| \begin{array}{c} 4 \\ \text{Card} \end{array} \left| \begin{array}{c} 8 \\ \end{array} \right|$

Card = ^ EOD, (A4)

(15) Termination card

$\left| \begin{array}{c} 1 \\ N_{\text{card}} \end{array} \right| \begin{array}{c} 4 \\ \text{Card} \end{array} \left| \begin{array}{c} 8 \\ \end{array} \right|$

Card = EOP, (A4)

## 7. Output Parameters

The outprints are self-explanatory and consist of:

### a. Array descriptive output:

- o anchor locations
- o cuts information
- o cable properties
- o device properties
- o current field

### b. Structural output:

- o current condition
- o cable forces and angles at each anchor
- o location of the array junctions
- o displacement of these junctions from the no-current coordinates
- o cable forces and angles at each junction
- o maximum and minimum tension and their location for each cable
- o location and displacement of devices from the no-current coordinates
- o tension at devices.

A sample output for the tri-moor is given in Appendix B-2.

# 8 . File Status

NAME	DESCRIPTION	STATUS	
		* ON TAPE	ON DISK
DESADEK	Source program	X	
DESADW	Source program modified to accept variable current directions.	X	X
DSDLGØK	Compiled program on NCS system	X	
GØDESAD	Procedure file to run by Scope system (Compile, catalog LGØ file, and run.)	X	X
GØDSAD	Procedure file to run by Scope system (run LGØ file.)	X	X
GØDSW	Procedure file to run by Scope system (Compile and run.)	X	X
DATA	Bench data from Ref. 1	X	X
DATASP	Data file for single post near	X	X
DATAGP1	Data file for goal post moor	X	X
DATAGP8	Data file for goal post w/eight additonal buoys on each post.	X	X
DATABGP	Data file for braced goal post post moor.	X	X
DATASS	Data file for sea spider moor.	X	X
DATA4	Data file for single post single buoy moor.	X	X
DATAW	Data file for DOCMS moor:	X	X

\*TAPE NAME: KW2233      Created on 8-3-77



## 9. Computer Requirements and Cost

### a. Requirements

DESADE is a Fortran IV program and is ready for CDC Fortran IV compilers. Memory requirements are approximately 30,000 words in a single precision. Access to one, two or three magnetic tape units, depending on the I/O options chosen, is required by the program.

### b. Cost

Computer costs for the test runs are shown in the following table :

ARRAY CONFIGURATION	I/O time (SEC)	Execution time* (SEC)	total* SBU UNITS (SEC)	ESTIMATE** TOTAL COST (\$)
Single post	14	13	5/30's	9
Sea spider	14	54	110/30's	34
Goal Post	14	24	36/30's	16
Braced Goal Post	14	84	208/10's	58

\* CDC Computer charge unit

\*\* Based on over night rate (priority 2) plus terminal connecting charge and I/O charge. Current rates are (July, 1977) :

Priority	(Overnight)	(Daytime)		
	2	3	4	5
Rate (\$)	.24	.28	.34	.45

Terminal connection: \$9/hr.  
Terminal I/O: \$20/1000 character

Note the compilation time (~ 4.5 sec) was saved for each run through the use of a compiled binary file (DESLGO)

## 10. Run Steps

(1) Log in XXXXXXXXXXXX KB, IHJ11\*

[illegible]

(2) Prepare data file

- a. Either create your own file (see next section on how to establish data file).
- b. Or edit existing data files of similar array configuration.
- c. A sample of data file is shown on page 20 .

(3) Prepare run procedure file

- a. Edit existing file to desired condition (job priority, data file name, etc.)
- b. A sample of run procedure file is shown on page 19 .

(4) Submit job

- a. See example on page 19 .

(5) Check for job status

- a. See example on page 19.

(6) Get day file when job is ready for output.

- a. See example on page 19.

(7) Print output

- a. See example on page 19.

\* The underlined characters are user's entry. Consult with FPO-1E to update these entries.

— priority

— Data file

---

Assigned job name

---

Check for job status

Job AE0CBQK is ready for print

Get day file

---

\* The underlined characters are user's entries.

## References

1. R. A. Skop, and J. Mark, 'A Fortran IV program for computing the static deflections of structural cable arrays', NRL Report 7640, August 1973.
2. N. D. Albertsen, 'A survey of techniques for the analysis and design of submerged mooring systems', CEL Report 815, Aug. 1974.
3. T. R. Kretschmer, G.A. Edgerton, and N. D. Albertsen, 'Seafloor construction experiment, SEACON II - an instrumented Tri-moor for evaluating undersea cable structure technology', CEL Report R848, Dec. 1976.
4. R. A. Skop, and G. J. O'Hara, 'The static equilibrium configuration of cable arrays by use of the method of imaginary reactions', NRL report 6819, Feb. 1969.
5. R. A. Skop, and R. E. Kaplan, 'The static configuration of a tri-moored, subsurface, buoy - cable array acted on by current - induced forces', NRL Report 6894, May 1969.
6. R. L. Webster, 'DSSM computer program', GE Report 1976.

## APPENDIX A

### Results of Test Runs

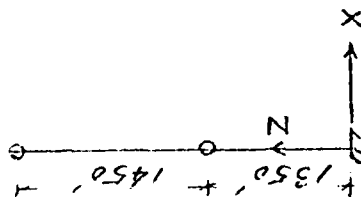
The test runs were made for the Linear Chair candidate configurations. The results have been used to compare the calculations made by DTNSRDC using the DSSM computer program (Ref. 6). In the following tables the DTNSRDC's results are enclosed by parentheses. Good agreement exists in most of the cases. The computer costs are comparable. However the finite element representation for each cable member is much finer in the test run calculations than those made by DTNSRDC.

Single Point Moor — Deviation in feet from zero position

Cable — 1 1/4" Dia.

Current — Uniform = .2 Knots

Buoyancy (lbs)	Top Buoy		Bottom Buoy	
	X - Axis Y	Z - Axis	X - Axis Y	Z - Axis
3000	(13.74) 14.6	(5.74) 5.9	(7.94) 8.4	(3.73) 3.8
4000	(10.18) 10.9	(7.87) 8.1	(5.87) 6.3	(5.09) 5.2

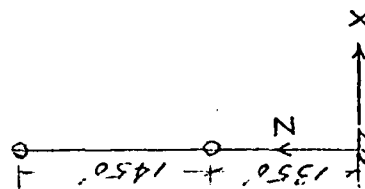


Single Point Moor — Deviation in feet from zero position

Cable — 1 1/4" Dia.

Current — St. Croix

Buoyancy (lbs)	Top Buoy		Bottom Buoy	
	X - Axis Y	Z - Axis	X - Axis Y	Z - Axis
3000	(13.26) 15.5	(5.74) 5.9	(6.03) 6.9	(3.74) 3.8
4000	(10.01) 12.1	(7.88) 8.1	(4.53) 5.3	(5.10) 5.2

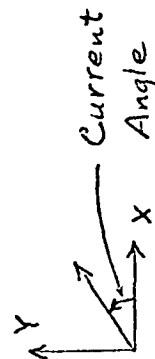
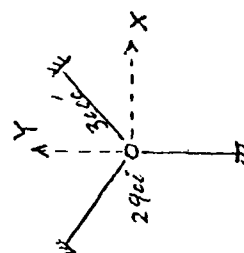


Sea Spider Moor — Deviation in feet from zero position

Cable —  $1\frac{1}{4}$ " Dia. Buoyancy — 3000 lbs

Current — Uniform = .2 Knots

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	60°	90°	0°	30°	60°	90°	0°	30°	60°	90°
Top	(1.91)	(.46)	(.28)	(0)	(-.78)	(.55)	(2.04)	(2.71)	(-5.87)	(-5.84)	(-5.87)	(-5.9)
	2.4	1.1	.2	0	-.7	.7	2.3	3.1	-6.0	-5.9	-6.0	-6.0





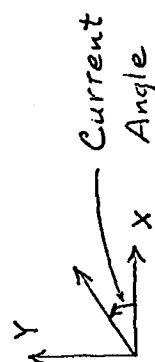
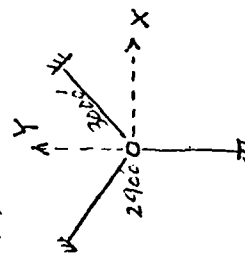
Sea Spider Moor — Deviation in feet from zero position

Cable —  $1\frac{1}{4}$ " Dia. Buoyancy — 3000 lbs.

Current — St. Croix

Buoy Location	X - Axis			Y - Axis			Z - Axis		
	Current Angle			Current Angle			Current Angle		
	0°	30°	60°	90°	0°	30°	60°	90°	
Top ( $G_0=12$ )	8.7	8.2	5.0		1.0	4.9	7.0	-6.1	-6.2 -6.1

Top ( $G_0=47$ ) 10.0 9.7 5.9 0 1.3 5.7 8.0 8.6 -6.3 -6.2 -6.1  
(10.47) (0) (1.48) (9.38) (-6.2) (-6.1)



Sea Spider Moor — Deviation in feet from zero position

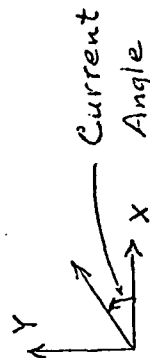
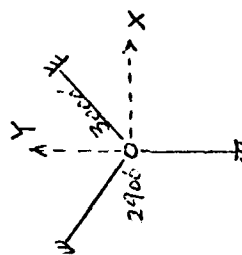
Cable —  $1\frac{1}{4}$ " Dia. Buoyancy — 4000 lbs.

Current — Uniform = .2 knots

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	60°	90°	0°	30°	60°	90°	0°	30°	60°	90°
Top ( $C_0 = .47$ )	(-.84) -.5	(-1.19) -1.4	(-.88) -1.1	(0) 0	(-.53) -.5	(-.69) -.6	(-.46) -.4	(-.31) -.1	(-1.24) -1.3	(-1.23) -1.2	(-1.24) -1.2	(-1.35) -1.3

Top  
( $C_0 = .12$ )

- .6 -1.5 -1.2 - .5 - .7 - .4 -1.3 -1.2 -1.2

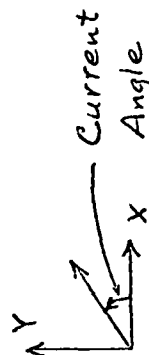
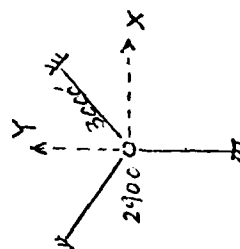


Sea Spider Moor — Deviation in feet from zero position

Cable —  $1\frac{1}{4}$ " Dia. Buoyancy — 4000 lbs

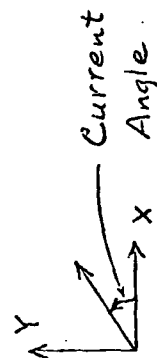
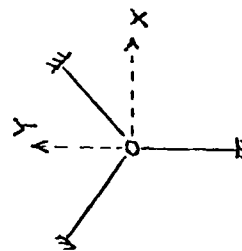
Current — St. Croix

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	60°	90°	0°	30°	60°	90°	0°	30°	60°	90°
Top	(3.0)			(0)	(.19)			(2.87)	(-1.26)			(-1.25)
				0				2.7				-1.3



Sea Spider Moor — Deviation in feet from zero position  
 Cable —  $1\frac{1}{4}$ " Buoyancy — 3000 lbs  
 Current — Uniform = .3 kt.

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	60°	90°	0°	30°	60°	90°	0°	30°	60°	90°
Top	(12.0) 13.9	(7.0) 10.2	6.2	(0)	(-1.4) -7	(4.0) 5.9	12.4		-8.8	-8.4	-8.8	



Goal Post Moor — Deviation in feet from zero position

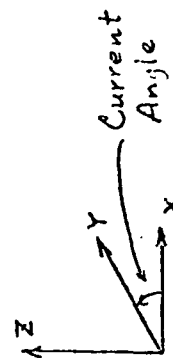
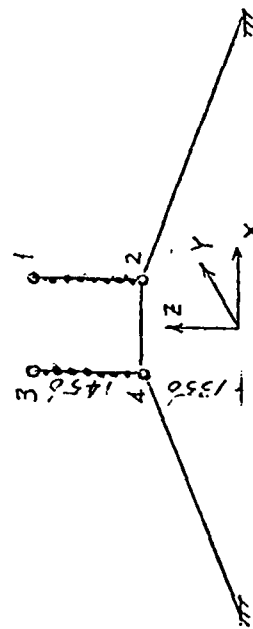
Cable —  $1\frac{3}{4}$ " Dia.

Buoyancy — 2000 lbs plus

Current — Uniform = .2 knots

8 @ 250 lbs

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	45°	90°	0°	30°	45°	90°	0°	30°	45°	90°
Top Right 1	(8.72) 8.9		6.4	(.46) .5	0		18.1	(28.27) 28.4	(16.37) 16.5		16.5	(15.75) 16.0
Bottom Right 2	(.66) .7		.6	(.46) .5	0		12.4	(20.21) 20.2	(15.88) 16.0		16.0	(15.26) 15.5
Top Left 3	(7.8) 7.9		5.5	(.46) .5	0		18.1	(28.27) 28.4	(15.43) 15.6		15.7	(15.75) 16.0
Bottom Left 4	(-.26) -.2		-.3	(-.46) -.5	0		12.4	(20.21) 20.2	(14.94) 15.1		15.2	(15.26) 15.5

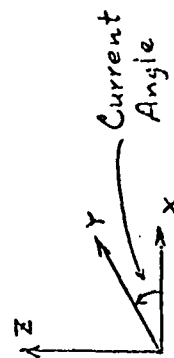
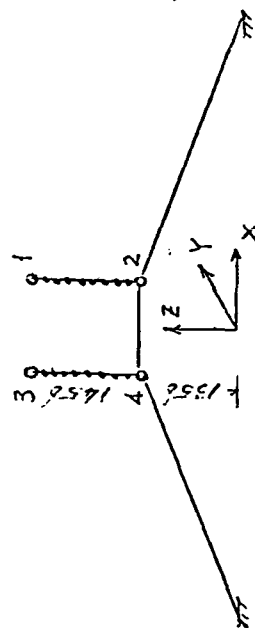


Goal Post Moor — Deviation in feet from zero position

Cable —  $1 \frac{3}{4}$ " Dia. Buoyancy — 2000 lbs plus

Current — St. Croix 8 @ 250 lbs

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	45°	90°	0°	30°	45°	90°	0°	30°	45°	90°
Top Right 1	(10.7) 11.9		8.5	(.46) .4	0		16.4	(22.15) 24.2	(16.24) 16.4		16.4	(15.88) 16.1
Bottom Right 2	(.62) .7		.6	(.46) .4	0		8.5	(12.09) 13.0	(15.57) 15.9		15.9	(15.37) 15.6
Top Left 3	(9.75) .9		7.6	(-.46) -.5	0		16.4	(22.15) 24.5	(15.57) 15.7		15.8	(15.85) 16.1
Bottom Left 4	(-.3) -.3		-.4	(-.46) -.5	0		8.5	(12.09) 13.0	(15.09) 15.2		15.4	(15.37) 15.6



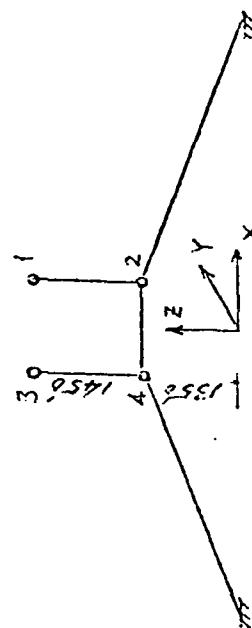
Goal Post Moor — Deviation in feet from zero position

Cable —  $1\frac{3}{4}$ " Dia.

Buoyancy — 3000 lbs.

Current — Uniform = .2 Knots

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	45°	90°	0°	30°	45°	90°	0°	30°	45°	90°
Top Right 1	(8.69) 9.2		6.6	(.46) .5	(0) 0		18.1	28.4	(16.34) 16.5		16.5	(15.76) 16.0
Bottom Right 2	(.65) .7		.6	(.46) .5	(0) 0		12.1	19.8	(15.85) 16.0		16.0	(15.27) 15.5
Top Left 3	(7.77) 8.3		5.7	(-.46) -.5	(0) 0		18.1	28.4	(15.48) 15.6		15.7	(15.76) 16.0
Bottom Left 4	(-.27) -.2		-.3	(-.46) -.5	(0) 0		12.1	19.9	(14.99) 15.1		15.2	(15.37) 15.5



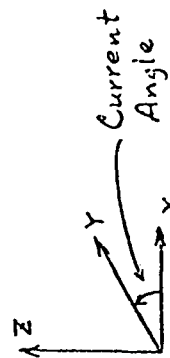
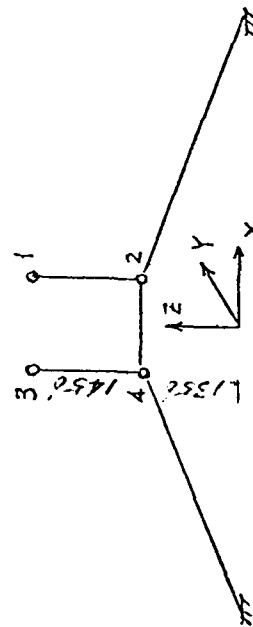
Goal Post Moor — Deviation in feet from zero position

Cable — 1 3/4" Dia.

Buoyancy — 3000 lbs.

Current — St. Croix

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	45°	90°	0°	30°	45°	90°	0°	30°	45°	90°
Top Right 1	(10.65) 12.5		8.9	(.44) .4	(0) 0		16.8	(22.46) 24.9	(16.22) 16.4		16.4	(15.85) 16.1
Bottom Right 2	(.61) .7		.6	(.44) .4	(0) 0		8.5	(11.83) 13.1	(15.75) 15.9		15.9	(15.37) 15.6
Top Left 3	(9.41) 11.5		8.0	(-.46) -.5	(0) 0		16.8	(22.46) 24.9	(15.57) 15.7		15.8	(15.85) 16.1
Bottom Left 4	(-.31) .3		-.4	(-.46) -.5	(0) 0		8.5	(11.83) 13.1	(15.10) 15.2		15.4	(15.37) 15.6





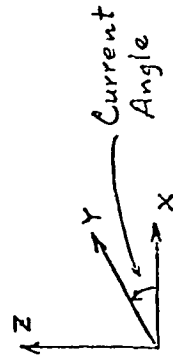
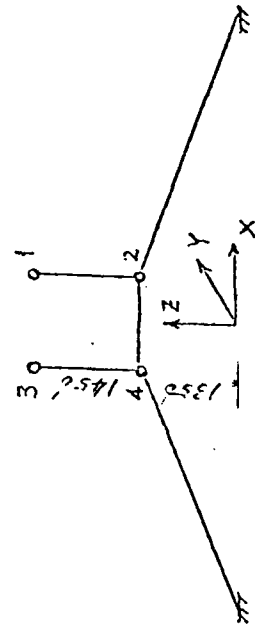
Goal post Moor — Deviation in feet from zero position

Cable —  $1\frac{3}{4}$ " Dia.

Buoyancy — 4000 lbs

Current — Uniform = .2 Knots

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	45°	90°	0°	30°	45°	90°	0°	30°	45°	90°
Top Right 1	(6.74) 7.2		5.3	(.64) .6	0		13.3	(20.09) 20.9	(22.90) 23.1		23.3	(22.51) 22.9
Bottom Right 2	(.78) .8		.8	(.64) .6	0		8.8	(14.13) 14.5	(22.24) 22.4		22.6	(21.82) 22.2
Top Left 3	(5.46) 5.9		4.0	(-.64) -.7	0		13.3	(20.09) 20.9	(22.27) 22.5		22.7	(22.51) 22.9
Bottom Left 4	(-.5) -.4		-5.5	(-.64) -.7	0		8.8	(14.33) 14.5	(21.59) 21.8		22.0	(21.82) 22.2



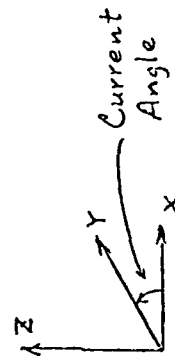
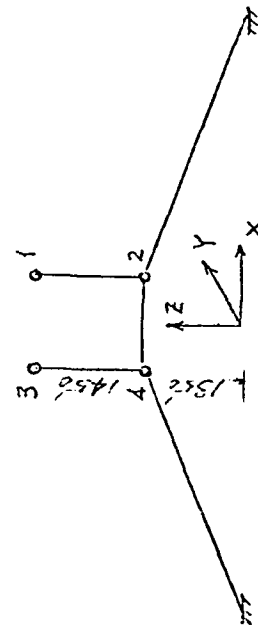
Goal Post Moor — Deviation in feet from zero position

Cable —  $1\frac{3}{4}$ " Dia.

Buoyancy — 4000 lbs.

Current — St. Croix

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	45°	90°	0°	30°	45°	90°	0°	30°	45°	90°
Top Right 1	(2.61) 10.3		1.4	(.64) .6	(0) 0		13.2	(16.64) 19.3	23.1		23.1	(22.55) 22.9
Bottom Right 2	(.76) .8		.7	(.64) .6	(0) 0		6.5	(8.86) 9.9	22.4		22.5	(21.87) 22.2
Top Left 3	(7.32) 8.9		6.1	(-.64) -.7	(0) 0		13.1	(16.64) 19.3	22.5		22.7	(22.55) 22.9
Bottom Left 4	(-.52) -.5		-.6	(-.64) -.7	(0) 0		6.5	(8.86) 9.9	21.9		22.	(21.87) 22.2



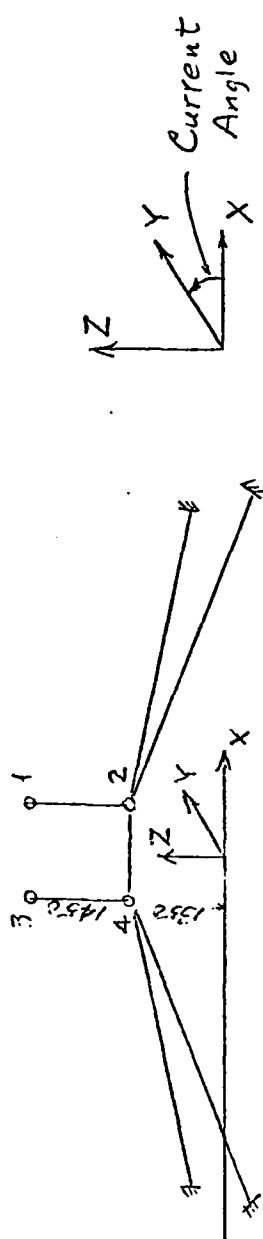
Braced Goal Post Moor — Deviation in feet from zero position

Cable —  $1\frac{3}{4}$ " Dia.

Buoyancy — 3000 lbs.

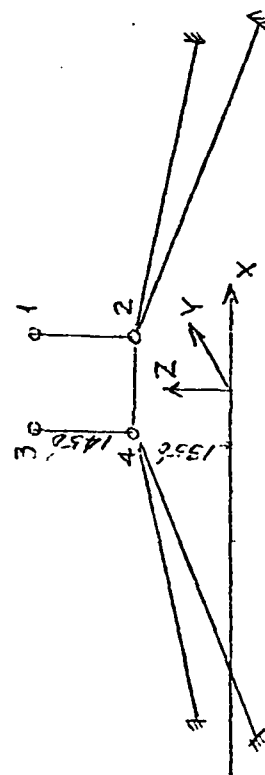
Current — Uniform = .2 Knots

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	60°	90°	0°	60°	90°	0°	60°	90°	0°	90°
Top Right 1	(8.41) 9.4		5.0	(.34) .4	.2		(8.24) 8.9	4.3		(3.15) 3.2		
Bottom Right 2	(.86) .9		.7	(.34) .4	.2		(.19) .4	3.8		(2.67) 2.7		
Top Left 3	(8.23) 8.7		4.3	(-.34) -.3	-.1		(8.24) 8.7	2.1		(3.15) 3.2		
Bottom Left 4	(.19) .2		0	(-.34) -.3	-.1		(.19) .1	1.6		(2.67) 2.7		



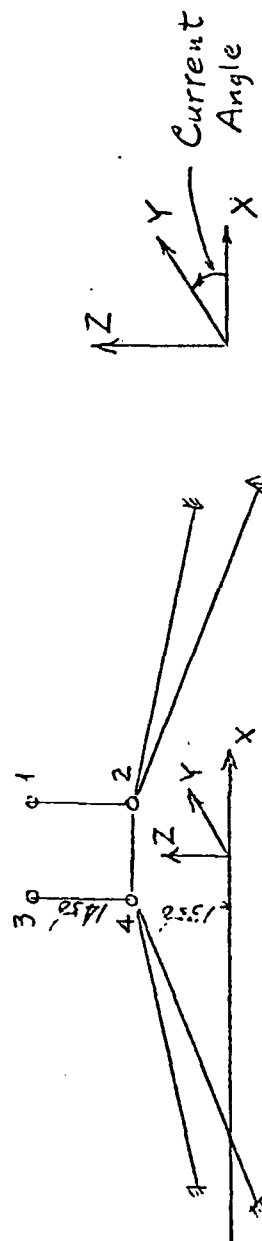
Braced Goal Post Moor — Deviation in feet from zero position  
 Cable —  $1\frac{3}{4}$ " Dia. Buoyancy — 4000 lbs.  
 Current — Uniform = .2 Knots

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	45°	90°	0°	45°	90°	0°	45°	90°	0°	45°
Top Right 1	(6.82) 7.3		5.3	(.46) .5	(0) .2		(6.1) 6.7	(7.45) 7.6		7.5	(6.68) 6.8	
Bottom Right 2	(.87) .9		.8	(.46) .5	(0) .2		(.15) .3	(6.77) 6.9		6.8	(6.0) 6.1	
Top Left 3	(5.88) 6.3		4.4	(-.46) -.5	(0) -.1		(6.1) 6.5	(5.94) 6.0		6.2	(6.68) 6.8	
Bottom Left 4	(-.09) -.1		-.1	(-.46) -.5	(0) -.1		(.15) .1	(5.23) 5.3		5.5	(6.0) 6.1	



Braced Goal Post Moor — Deviation in feet from zero position  
 Cable —  $1\frac{3}{4}$ " Dia. Buoyancy — 3000 lbs  
 Current — St. Croix

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	45°	90°	0°	45°	90°	0°	45°	90°		
Top Right 1	(11.69) 11.9		6.8	(.34) .4	(0) .2		(10.9) 11.4	(3.84) 3.8		4.1	(3.16) 3.2	
Bottom Right 2	(.7) .7		.8	(.34) .4	(0) .2		(.15) .3	(3.37) 3.4		3.6	(2.69) 2.7	
Top Left 3	(10.75) 11.1		6.1	(-.34) -.3	(0) -.1		(10.9) 11.2	(2.49) 2.4		2.3	(3.16) 3.2	
Bottom Left 4	(.03) .1		.1	(-.34) -.3	(0) -.1		(.15) .1	(2.02) 1.9		1.8	(2.69) 2.7	

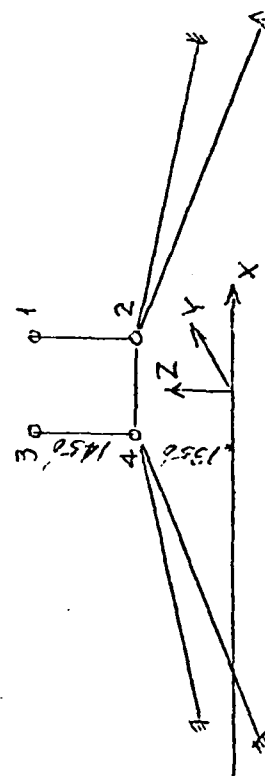


Braced Goal Post Moor — Deviation in feet from zero position

Cable —  $1\frac{3}{4}$ " Dia. Buoyancy — 4000 lbs.

Current — St. Croix

Buoy Location	X - Axis				Y - Axis				Z - Axis			
	Current Angle				Current Angle				Current Angle			
	0°	30°	45°	90°	0°	45°	90°	0°	45°	90°	0°	90°
Top Right 1	(8.72) 9.6		6.9	(.48) .5	(0) .2		(8.26) 9.0	(7.18) 7.3		(6.49) 6.8		
Bottom Right 2	(.74) .8		.7	(.48) .5	(0) .2		(.1) .3	(6.5) 6.6		(6.01) 6.1		
Top Left 3	(7.94) 8.5		5.9	(-.48) -.5	(0) -.1		(8.26) 8.8	(6.2) 6.3		(6.69) 6.8		
Bottom Left 4	(-.21) -.2		-.2	(.48) .5	(0) -.1		(.1) .1	(5.52) 5.6		(6.01) 6.1		



APPENDIX B

Sample of Input and Output

Sample Input  
(Tri-moor)

B-2



# PROBABLE POSITION OF SINKING SHIP

SHIP NAME: USS ARIZONA      POSITION AT SINKING: 16° 00' N, 157° 00' W

## SHIP DATA

SHIP NO.: BB-39      TYPE: BATTLESHIP  
 TONNAGE: 3500      LENGTH: 180      BEAM: 30  
 DRAFT: 10      SPEED: 21      RANGE: 10000

## WRECK DATA

WRECK NO.: 1      DEPTH: 100      ORIENTATION: 090  
 SURFACE AREA: 1000      VOLUME: 10000      WEIGHT: 100000

## WRECK DATA

WRECK NO.: 2      DEPTH: 100      ORIENTATION: 090  
 SURFACE AREA: 1000      VOLUME: 10000      WEIGHT: 100000

## WRECK DATA

WRECK NO.: 3      DEPTH: 100      ORIENTATION: 090  
 SURFACE AREA: 1000      VOLUME: 10000      WEIGHT: 100000

## WRECK DATA

WRECK NO.: 4      DEPTH: 100      ORIENTATION: 090  
 SURFACE AREA: 1000      VOLUME: 10000      WEIGHT: 100000

## WRECK DATA

WRECK NO.: 5      DEPTH: 100      ORIENTATION: 090  
 SURFACE AREA: 1000      VOLUME: 10000      WEIGHT: 100000

# ARRAY JUNCTIONS

JUNC. NO.	CABLE AT JUNCTION	TENSION AT JUNCTION	CABLE ANGLES WRT X-AXIS XY-PLANE	X-COORD OF JUNCTION	Y-COORD OF JUNCTION	Z-COORD OF JUNCTION	DISPLACEMENT FROM NO CURRENT LOC. X-DISP Y-DISP Z-DISP
4	1	147.59	-72.64	2.4	1070.0	0.0	0.0 0.0 0.0
4	2	147.59	-72.64	2.4	1070.0	0.0	0.0 0.0 0.0
4	3	147.59	-72.64	2.4	1070.0	0.0	0.0 0.0 0.0

# INDEXED DEVICES ALONG ARRAY CABLES

INDEX NO.	DEVICE NO.	COORDINATE	TENSION AT DEVICE	X-COORD OF DEVICE	Y-COORD OF DEVICE	Z-COORD OF DEVICE	DISPLACEMENT FROM NO CURRENT LOC. X-DISP Y-DISP Z-DISP
1	1	147.59	147.59	2.4	1070.0	0.0	0.0 0.0 0.0
2	2	147.59	147.59	2.4	1070.0	0.0	0.0 0.0 0.0
3	3	147.59	147.59	2.4	1070.0	0.0	0.0 0.0 0.0

ARRAY EQUILIBRIUM WITH CURRENT FROM 30.00 DEGREES

# ARRAY ANCHORS

JUNC. NO. OF ANCHOR	CABLE AT ANCHOR	TENSION AT ANCHOR	X-COORD OF ANCHOR	Y-COORD OF ANCHOR	Z-COORD OF ANCHOR	DISPLACEMENT FROM NO CURRENT LOC. X-DISP Y-DISP Z-DISP
1	1	147.59	2.4	1070.0	0.0	0.0 0.0 0.0
2	2	147.59	2.4	1070.0	0.0	0.0 0.0 0.0
3	3	147.59	2.4	1070.0	0.0	0.0 0.0 0.0

# ARRAY CABLES

CABLE NO.	MAXIMUM TENSION	S-COORD OF TENSION	MINIMUM TENSION	S-COORD OF TENSION	MAXIMUM DISP.	S-COORD OF DISP.	LOCATION OF THIS POINT X-COORD Y-COORD Z-COORD	NO CURRENT LOC. OF THIS POINT X-COORD Y-COORD Z-COORD
1	1456.1	0.0	676.7	3000.0	7.9	1320.0	244.7 150.4 1497.8	244.7 150.4 1497.8
2	1456.7	3000.0	676.2	0.0	7.9	1680.0	7.0 236.7 1497.8	7.0 236.7 1497.8
3	1167.7	0.0	588.2	3000.0	3.9	2230.0	435.7 236.7 432.3	435.7 236.7 432.3

# ARRAY JUNCTIONS

JUNC. NO.	CABLE AT JUNCTION	TENSION AT JUNCTION	CABLE ANGLES WRT X-AXIS XY-PLANE	X-COORD OF JUNCTION	Y-COORD OF JUNCTION	Z-COORD OF JUNCTION	DISPLACEMENT FROM NO CURRENT LOC. X-DISP Y-DISP Z-DISP
4	1	147.59	-72.64	2.4	1070.0	0.0	0.0 0.0 0.0
4	2	147.59	-72.64	2.4	1070.0	0.0	0.0 0.0 0.0
4	3	147.59	-72.64	2.4	1070.0	0.0	0.0 0.0 0.0

# ARRAY CABLES

CABLE NO.	MAXIMUM TENSION	S-COORD OF JUNCTION	MINIMUM TENSION	S-COORD OF JUNCTION	MAXIMUM DISP.	S-COORD OF JUNCTION	LOCATION OF THIS POINT	NO CURRENT LOC. OF THIS POINT
1	1199.6	0.0	780.0	3000.0	3000.0	0.0	X COORD Y COORD Z COORD	X COORD Y COORD Z COORD
2	1350.6	3000.0	789.7	0.0	0.0	0.0		
3	1259.5	0.0	780.0	3000.0	3000.0	0.0		

JUNC. NO.	CABLE AT JUNCTION	TENSION AT JUNCTION	CABLE ANGLED WRT X-AXIS	XY-PLANE	X COORD	Y COORD	Z COORD	DISPLACEMENT FROM NO CURRENT LOC.
1	1	1359.5	149.99	-70.70	0.0	0.0	3090.9	X DISP Y DISP Z DISP
2	2	1350.1	-70.00	-70.70				
3	3	1352.5	30.01	-70.70				

## INDEXED DEVICES ALONG ARRAY CABLES

DEVICE CABLE INDEX	S	TENSION AT JUNCTION	DEVICE COORDINATE	X COORD	Y COORD	Z COORD	DISPLACEMENT FROM NO CURRENT LOC.
1	1	1359.5	149.99	0.00	0.00	3090.9	X DISP Y DISP Z DISP

## ARRAY ANCHORS

JUNC. NO. OF ANCHOR	CABLE AT ANCHOR	TENSION AT ANCHOR	X-COMP	Y-COMP	Z-COMP	HORZ. COMP	CABLE ANGLE WRT X-AXIS	XY-PLANE	X COORD	Y COORD	Z COORD
1	1	746.2	277.1	151.7	0.0	0.0	27.0	20.10	70.00	0.00	0.00
2	2	780.1	9.1	252.4	252.4	252.4	26.0	31.0	70.00	0.00	0.00
3	3	614.9	-134.9	111.7	592.7	111.7	23.0	148.00	0.00	0.00	0.00

## ARRAY CABLES

CABLE NO.	MAXIMUM TENSION	S-COORD OF JUNCTION	MINIMUM TENSION	S-COORD OF JUNCTION	MAXIMUM DISP.	S-COORD OF JUNCTION	LOCATION OF THIS POINT	NO CURRENT LOC. OF THIS POINT
1	1259.6	0.0	746.2	3000.0	3000.0	0.0	X COORD Y COORD Z COORD	X COORD Y COORD Z COORD
2	1350.6	3000.0	780.1	0.0	0.0	0.0		
3	1194.4	0.0	614.9	3000.0	3000.0	0.0		

B-5

1 3

NO. OF CABLES IS 3

CABLE NO.	S-L JUNC	LENGTH	DIAMETER	WEIGHT/LENGTH	BRAC COEFFICIENT	RIGIDITY	CONSTITUTIVE EXPONENT	NO. OF ELEMENTS
1	4	3000.0	1.250	-.200	1.270	1963500.	1.000	50
2	2	3000.0	1.250	-.200	1.270	1963500.	1.000	50
3	4	3000.0	1.250	-.200	1.270	1963500.	1.000	50

PROPERTIES OF THE DEVICES LOCATED AT JUNCTIONS ARE AS FOLLOWS

DEVICE JUNC. NO.	DEVICE WEIGHT	DEVICE BRAC COEFFICIENT	DEVICE FRONTAL AREA
4	4000.00	.120	20.50

TOTAL NO. OF INDEXED DEVICES IS 1

CURRENT FIELD OPTION IS 1

Z COORDINATE OF CURRENT	VELOCITY OF CURRENT AT Z
0.00	.10
400.00	.10
2400.00	.10
2700.00	.24
2700.00	.53

ACCURACY REQUIRED IN CALCULATIONS IS 1.00

DEVICE LOCATION OUTPUT RECORD 1 REFERS TO THIS ARRAY  
1 ARRAY EQUILIBRIUM WITH NO CURRENT

ARRAY ANCHORS

JUNC. NO. OF ANCHOR	CABLE AT ANCHOR	TENSION AT ANCHOR	X-COMP	Y-COMP	Z-COMP	HOR. COMP	CONC
1	1	700.0	230.7	173.3	733.1	265.4	265.4
2	2	700.7	0.0	266.5	733.0	264.0	264.0

B-4

CABLE ANCHORS	X AXIS	Y AXIS	Z AXIS
1	230.7	173.3	733.1
2	0.0	266.5	733.0

END OF THE LOAD 101  
 END OF THE LOAD 110713

TRANSFER ADDRESS --- DECADE 55502

.400 OF SECONDS 1241000 CM STORAGE USED 55 TALLE NEEDED

1 ERRORS IN PARAMETRIC STUDY SOURCE DECK NUMBER 0

CARD NO.	CARD TYPE	OTHER INFORMATION

NO ERRORS DETECTED  
 1 ERRORS IN PARAMETRIC STUDY SOURCE DECK NUMBER 1

CARD NO.	CARD TYPE	OTHER INFORMATION

NO ERRORS DETECTED  
 PHYSICAL CHARACTERISTICS OF THE STRUCTURAL CABLE ARRAY

NO. OF ANCHORS IS 3

JUNCTION NO.	X-COORDINATE	Y-COORDINATE	Z-COORDINATE
1	-665.20	394.10	0.00
2	0.00	-760.10	0.00
3	665.20	394.10	0.00

NO. OF JUNCTIONS IN ORIGINAL ARRAY IS 4 ✓

NO. OF CUTS MADE IN ORIGINAL ARRAY IS 2 ✓

JUNCTION NO.	JUNCTION NO.
OF CUT	AT WHICH CUT MADE
5	1
6	3

Sample Output  
 (Tri-moor)

Appendix C  
Source Program Listing

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      PROGRAM DESADE (INPUT, OUTPUT, TAPE2, TAPE3, TAPE5=INPUT, TAPE6=OUTPUT) DES001
C
C A FORTRAN IV PROGRAM FOR COMPUTING THE STATIC DEFLECTIONS DES002
C OF STRUCTURAL CABLE ARRAYS DES003
C
C BY RICHARD A. SKOP AND JAMES MARK, OCEAN TECHNOLOGY DIVISION, DES004
C NAVAL RESEARCH LABORATORY, WASHINGTON, D. C. DES005
C DES006
C DES007
C DES008
      COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,L,ES,FCAB,RCAB,JUMP,DES009
      1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO DES010
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC, DES011
      1CDCAB,DCAB,FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG, DES012
      2OFLG,NIR,THETAS,THETAe,COMPD,THETAJ,NJUNC,RHO,TEST, DES013
      3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT, DES014
      4WCAB,IDEV,ICHECK,NDEV,NDATC DES015
      DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44) DES016
      1) DES017
      DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22) DES018
      DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22) DES019
      DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22) DES020
      DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14) DES021
      DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22) DES022
      DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000) DES023
      DIMENSION ICHECK(44) DES024
      DIMENSION DATAT(2150,10) DES025
      EQUIVALENCE (DATAT(1),FEJUNC(1)) DES026
      INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG DES027
      INTEGER PATH DES028
      REAL IR,IRS DES029
C DES030
C CALL INPUT TO READ DATA AND IDENTIFY ERRORS DES031
C DES032
      ITIME=1 DES033
      1000 CALL INPUT DES034
C DES035
C CHECK TO SEE IF ANY ERRORS IN DATA DES036
C DES037
      IF(FATE.NE.0.) GO TO 10000 DES038
C DES039
C GET HERE IF NO ERRORS -- PRINT OUT PHYSICAL CHARACTERISTICS OF ARRAY DES040
C DES041
      WRITE(IPRNT,1001) DES042
      1001 FORMAT(///,5X,18HNO ERRORS DETECTED) DES043
      CALL PHSOUT DES044
C DES045
C KMULT IS A MULTIPLIER FOR CHANGING CURRENT ANGLE THETA DES046
C DES047
      KMULT=0 DES048
C DES049
C JUMP=0---NO CURRENT JUMP=1---CURRENT DES050
C DES051
      JUMP=0 DES052
C DES053
C GET HERE TO CALCULATE FORCES AND IF SUCCESSIVE APPROXIMATION ROUTINE DES054
C NOT SATISFIED -- ZERO FORCES DES055

```

```

C
2011 DO 2012 J=1,NJUNC
      DO 2012 I=1,3
2012 FEJUNC(I,J)=0.
      DO 2013 N=1,NCAB
        INNN=NNODE(N)
        DO 2013 M=1,INNN
          DO 2013 I=1,3
2013 FCAB(I,M,N)=0.
C
C PICK UP DISCRETE DEVICE DATA FROM TEMPORARY STORAGE TAPE AND
C CALCULATE DEVICE FORCES -- DJNC FORCES ARE STORED IN FEJUNC --
C DCAB FORCES IN FCAB -- EFORCE(I) IS ROUTINE FOR CALCULATING
C DEVICE FORCES IN DIRECTION I
C
2015 READ(INTAPE,1) (DATA(K),K=1,10)
      1 FORMAT(F4.0,A4,8E15.8)
      IF(DATA(2).EQ.TEST(3)) GO TO 2017
      IF(DATA(2).EQ.TEST(4)) GO TO 2019
      IF(DATA(2).EQ.TEST(9)) GO TO 2021
      GO TO 2015
2017 K=DATA(3)
      DO 2018 J=1,3
        I=J
2018 FEJUNC(I,K)=FEJUNC(I,K)+EFORCE(I)
      GO TO 2015
2019 K= DATA(3)
      M= DATA(10)/H(K) + 1
      DO 2020 J=1,3
        I=J
2020 FCAB(I,M,K) = FCAB(I,M,K) + EFORCE(I)
      GO TO 2015
C
C GET HERE AT END OF TAPE
C
2021 REWIND INTAPE
C
C NOW CALCULATE THE FORCE/LENGTH IN DIRECTION I AT NODE M ON CABLE N
C CFORCE(I,M,N) IS ROUTINE FOR DOING THIS -- INTEGRATE BY TRAPEZOIDAL
C RULE OVER SEGMENT TO GET TOTAL FORCE AND ADD TO DCAB FORCES
C
      DO 2022 J=1,NCAB
        K=J
        INNN=NNODE(K)-1
        DO 2022 MM=1,INNN
          M=MM
          DO 2022 II=1,3
            I=II
2022 FCAB(I,M,K)=(CFORCE(I,M,K)+CFORCE(I,M+1,K))*H(K)/2.+FCAB(I,M,K)
C
C ALL FORCES ARE NOW CALCULATED AND EQUILIBRIUM CAN BE DETERMINED
C LEAP = 1 FIRST TIME THROUGH IMAGINARY REACTION ROUTINE
C LEAP = 2 ANY OTHER TIME
C SKIP THIS SECTION IF NO IR'S
C
      IF(INIR.EQ.0) GO TO 2031
      IF(JUMP.EQ.0) CALL START
      LEAP=1
C

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C INITIALIZE DELTA
C
  DELTA=DELTAI
C
C GET HERE TO INITIALIZE TOTAL FORCES AT THE JUNCTIONS, TFJUNC, AND
C IF THE IMAGINARY REACTION ITERATION NOT SATISFIED -- ALSO IF NO IR'S
C
2031 DO 2032 J=1,NJUNC
      DO 2032 I=1,3
2032 TFJUNC(I,J) = FEJUNC(I,J)
C
C ADD APPROPRIATE REACTIONS TO TFJUNC -- SKIP THIS SECTION IF NO IR'S
C
  IF(NIR.EQ.0) GO TO 2036
  DO 2035 J=1,NJUNC
  DO 2035 K=1,NIR
    IF( (J.EQ.IRJUNC(K)).OR.(J.EQ.ERJUNC(K)) ) GO TO 2033
  GO TO 2035
2033 DO 2034 I=1,3
2034 TFJUNC(I,J) = TFJUNC(I,J) + IR(I,J)
2035 CONTINUE
C
C TFJUNC IS NOW DETERMINED AND THE REACTIVE FORCES IN THE ARRAY, RCAB,
C CAN BE CALCULATED BY SUMMING FROM THE FREE ENDS TO THE FIXED ANCHOR
C
2036 DO 2047 N=1,NCAB
  INDEX= NCAB+1-N
  K= PATH(INDEX)
  INNN=NNODE(K)
  INLJ=LJUNC(K)
  DO 2041 I=1,3
2041 RCAB(I,INNN,K)=TFJUNC(I,INLJ)
  DO 2044 L=1,NCAB
    IF(LJUNC(K).EQ.ZJUNC(L)) GO TO 2042
  GO TO 2044
2042 DO 2043 I=1,3
2043 RCAB(I,INNN,K)=RCAB(I,INNN,K)+RCAB(I,1,L)
2044 CONTINUE
  DO 2046 MM=1,INNN
  M=INNN+1-MM
  IF(M.EQ.1) GO TO 2047
  DO 2045 I=1,3
2045 RCAB(I,M-1,K)=RCAB(I,M,K)+FCAB(I,M-1,K)
2046 CONTINUE
2047 CONTINUE
C
C ALL REACTIVE FORCES ARE NOW DETERMINED AND THE CONFIGURATION OF THE
C ARRAY, PCAB AND PJUNC, CAN BE FOUND BY INTEGRATING FROM THE FIXED
C ANCHOR TO THE FREE ENDS -- INTEGRATION BY THE TRAPEZOIDAL RULE IS
C AGAIN USED
C
  DO 2054 N=1,NCAB
  X=PATH(N)
  INLN=LJUNC(K)
  INNN=NNODE(K)
  INZJ=ZJUNC(K)
  DO 2051 I=1,3
2051 PCAB(I,1,K)=PJUNC(I,INZJ)
  DO 2052 MM=2,INNN

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DES173

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      M=MM
      DO 2052 I=1,3
      I=I
2052  PCAB(I,M,K)=PCAB(I,M-1,K)+(EXCAB(M-1,K)*RCAB(I,M-1,K)/TCAB(M-1,K)
      1+EXCAB(M,K)*RCAB(I,M,K)/TCAB(M,K))*H(K)/2.
      DO 2053 I=1,3
2053  PJUNC(I,INLN)=PCAB(I,INNN,K)
2054  CONTINUE
C
C  ARRAY CONFIGURATION NOW DETERMINED -- CHECK TO SEE IF IT SATISFIES
C  GEOMETRIC CONSTRAINTS -- SKIP THIS SECTION IF NO IR'S
C
      IF(NIR.EQ.0) GO TO 2071
C
C  CALCULATE ERROR E
C
      E2=0.
      DO 2061 N=1,NIR
      KEN=ERJUNC(N)
      KIN=IRJUNC(N)
      DO 2061 I=1,3
2061  E2=E2+( PJUNC(I,KEN) - PJUNC(I,KIN) )**2
      E=SQRT(E2)
C
C  COMPARE ERROR TO ACCURACY REQUIREMENTS
C
      IF(E.LE.COMPD/10.) GO TO 2071
C
C  GET HERE IF GEOMETRIC CONSTRAINTS NOT SATISFIED
C
      GO TO (2062,2065),LEAP
C
C  GET HERE FIRST TIME THROUGH IMAGINARY REACTION ROUTINE
C
2062 LEAP=2
C
C  STORE SUCCESSFUL POSITIONS AND REACTIONS
C
2063 ES=E
      DO 2064 N=1,NIR
      KEN=ERJUNC(N)
      KIN=IRJUNC(N)
      DO 2064 I=1,3
      PJUNCS(I,KEN)=PJUNC(I,KEN)
      PJUNCS(I,KIN)=PJUNC(I,KIN)
2064  IRS(I,KIN)=IR(I,KIN)
      GO TO 2066
C
C  GET HERE ANY OTHER TIME THROUGH IMAGINARY REACTION ROUTINE
C  SEE IF ITERATION SUCCESSFUL
C
2065 IF(E.LT.ES) GO TO 2063
C
C  REDUCE DELTA IF NOT SUCCESSFUL INTERATION
C
      DELTA=DELTA/2.
C
C  CALCULATE NEW IMAGINARY AND EQUILIBRATING REACTIONS AND GO BACK TO
C  RECALCULATE ARRAY EQUILIBRIUM

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C
2066 DO 2067 N=1,NIR
      KEN=ERJUNC(N)
      DO 2067 I=1,3
2067 IR(I,KEN)=0.
      DO 2068 N=1,NIR
      KEN=ERJUNC(N)
      KIN=IRJUNC(N)
      DO 2068 I=1,3
      IR(I,KIN)=IRS(I,KIN)+DELTA*(PJUNCS(I,KEN)-PJUNCS(I,KIN))/ES
2068 IR(I,KEN)=IR(I,KEN)-IR(I,KIN)
C
C CHECK CHANGES IN IMAGINARY REACTIONS
C
      DO 2070 N=1,NIR
      KIN=IRJUNC(N)
      DO 2070 I=1,3
      IF(IR(I,KIN).NE.IRS(I,KIN)) GO TO 2031
2070 CONTINUE
C NO CHANGES -- TIME TO QUIT
C
      CALL ERROR
      GO TO 10000
C
C GET HERE IF ACCURACY REQUIREMENTS SATISFIED OR NO IRTS
C OUTPUT EQUILIBRIUM IF NO CURRENT -- IF CURRENT, FIRST CHECK TO SEE
C IF ACCURACY REQUIREMENT SATISFIED BY SUCCESSIVE APPROXIMATIONS
C
2071 JUM=JUMP+1
      GO TO (2072,2075),JUM
2072 IF((OFLG.EQ.0).OR.(OFLG.EQ.2)) CALL STROUT
      IF((OFLG.EQ.1).OR.(OFLG.EQ.2)) CALL TAPOUT
      IF(OFLG.EQ.1) GO TO 2100
      IF(JUM.NE.1) GO TO 2100
      DO 2200 N=1,NCAB
      INNN=NNODE(N)
      DO 2200 M=1,INNN
      DO 2200 I=1,3
      PCABO(I,M,N)=PCAB(I,M,N)
2200 RCABO(I,M,N)=RCAB(I,M,N)
      DO 2201 N=1,NJUNC
      DO 2201 I=1,3
2201 PJUNCO(I,N)=PJUNC(I,N)
C
C APPLY CURRENT IF REQUIRED
C
2100 IF(IVOPT.EQ.0) GO TO 9999
      JUMP=1
      THETA=THETAB + KMULT*THETAS
      IF(THETA.GT.THETAE) GO TO 9999
      KMULT=KMULT+1
C
C STORE EXISTING CONFIGURATION FOR COMPARISON PURPOSES
C
2073 DO 2074 N=1,NCAB
      INNN=NNODE(N)
      DO 2074 M=1,INNN
      DO 2074 I=1,3
2074 PCABE(I,M,N)=PCAB(I,M,N)

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C
C RECALCULATE FORCES
C
      GO TO 2011
C
C GET HERE IF CURRENT -- CHECK SUCCESSIVE APPROXIMATION ACCURACY
C
2075 DO 2077 N=1,NCAS
      DO 2077 M=1,INNN
      U=0.
      DO 2076 I=1,3
2076 U=U+(PCABE(I,M,N)-PCAL(I,M,N))*2
C
C IF NOT ACCURATE STORE CONFIGURATION AND RECALCULATE FORCES
C
      IF (SQRT(U).GT.COMPD) GO TO 2073
2077 CONTINUE
C
C GET HERE IF POSITION ACCURATE AND OUTPUT POSITION
C
      GO TO 2072
C
C GO BACK FOR MORE DATA
C
9999 GO TO 1000
10000 CONTINUE
      WRITE(IPRNT,10001)
10001 FORMAT(1H1)
      END

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SUBROUTINE INPUT
C
C THIS ROUTINE READS ALL DATA AND IDENTIFIES ERRORS IN
C DATA, DECK STRUCTURE, AND ARRAY REPRESENTATION
C
COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,
1CDCAB,DCAB,FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,
2OFLG,NIR,THETAS,THETA,COMP,THETA,NJUNC,RHO,TEST,
3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,
4WCAB,IDEV,ICHECK,NDEV,NDATC
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44
1)
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22)
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22)
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22)
DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14)
DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22)
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000)
DIMENSION ICHECK(44)
DIMENSION DATAT(2150,10)
DIMENSION ITEST(14)
EQUIVALENCE (DATAT(1),FEJUNC(1))
EQUIVALENCE (ITEST(1),TEST(1))
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
INTEGER PATH
REAL IR,IRS
C
C THIS IS THE BEGINNING OF THE INPUT SECTION
C INITIALIZE ALL CONSTANTS, FLAGS, ARRAYS, AND COUNTERS
C
IF(ITIME.NE.1) GO TO 999
ITEST(1)=4H IR
ITEST(2)=4H ANC
ITEST(3)=4H DJNC
ITEST(4)=4H DCAB
ITEST(5)=4H CAB
ITEST(6)=4H DEN
ITEST(7)=4H COMP
ITEST(8)=4H ANG
ITEST(9)=4H EOD
ITEST(10)=4H NJNC
ITEST(11)=4H VEL
ITEST(12)=4H NDAT
ITEST(13)=4H LUN
ITEST(14)=4H EOP
PIP=3.14159265/180.
IFEOD=0
NDATC=0
KFLG=0
DO 1000 I=1,1000
1000 IDEV(I)=0
DO 1001 I=1,44
1001 ICHECK(I)=0
DO 1002 I=1,22
1002 ICAB(I)=0
NANC=0

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INP058

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IFRHO=0
IFJNC=0
NIR=0
IROW=1
999 FATE=0.
C
C CHECK LOGICAL UNITS
C
  IF(I TIME.GT.1) GO TO 1003
  I TIME=2
  READ 1004,(DATA(I),I=1,10)
1004 FORMAT(F4.0,A4,8F8.0,F5.0,I3)
  IF(DATA(2).NE.TEST(13)) GO TO 9018
  IPRNT=DATA(4)
C
C GENERATE ERROR MESSAGE HEADER
C
998 WRITE(IPRNT,9100) NDATE
9100 FORMAT(1H1,46HEKROKS IN PARAMETRIC STUDY SOURCE DECK NUMBER ,I2,/,
  1 12X,4HCARD,3X,4HCARD,6X,5HOTHER/1H ,4X,4HTYPE,4X,3HNO.,3X,4HTYPE,
  23X,11HINFORMATION )
  IF(IFEOD.EQ.0) GO TO 13
  IF(IFEOD.NE.0) GO TO 12701
C
C READ ONE INPUT RECORD INTO DATA ARRAY
C
1003 CONTINUE
  IF(IFLG.EQ.0) READ(I READ,1004) (DATA(I),I=1,10),EX,NSEG
  IF(IFLG.EQ.1) READ(I READ,1104) (DATA(I),I=1,10),EX,NSEG
1104 FORMAT(F4.0,A4,8E15.8,/E12.5,I3)
C
C TYPE AND BRANCH
C
  IF(IFEOD.EQ.0) GO TO 1006
  IF((DATA(2).EQ.TEST(12)).OR.(DATA(2).EQ.TEST(14))) GO TO 1006
  GO TO 9018
1006 DO 1005 I=1,14
  IF(DATA(2).EQ.TEST(I)) GO TO (1,2,3,4,5,6,9018,9018,9,10,9018,
  1 12,9018,14),I
1005 CONTINUE
C
C GET HERE IF CARD UNIDENTIFIABLE
C
  GO TO 9000
C
C GET HERE IF IR CARD READ
C
  1 IF(DATA(3)-DATA(4)) 101,9001,101
  101 DO 102 I=3,4
  IF( (DATA(I).LT. 1.).OR.(DATA(I).GT.44.)) GO TO 9001
  102 CONTINUE
C
C GET HERE IF DATA OK
C COUNT IR AND STORE DATA
C
  NIR=NIR+1
  IRJUNC(NIR)=DATA(3)
  ERJUNC(NIR)=DATA(4)
  DO 103 N=1,NIR

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IF( (IRJUNC(NIR).EQ.ERJUNC(N)) GO TO 9004
IF( (IRJUNC(NIR).EQ.IRJUNC(N) ) .AND. (NIR.NE.N) ) GO TO 9004
IF( (ERJUNC(NIR).EQ.IRJUNC(N)) GO TO 9004
103 CONTINUE
GO TO 8000
C
C GET HERE IF ANC CARD READ
C
2 INDEX=DATA(3)
IF( (DATA(3).LT.1.) .OR. (DATA(3).GT.44.) ) GO TO 9001
IF( (ICHECK(INDEX).NE.0) GO TO 9002
C
C GET HERE IF DATA OK -- COUNT ANCHOR AND STORE DATA
C
NANC=NANC+1
ANJUNC(NANC)=DATA(3)
ICHECK(INDEX)=1
22 DO 21 I=1,3
21 PJUNC(I,INDEX)=DATA(I+3)
GO TO 8000
C
C GET HERE IF DJNC CARD READ
C
3 IF( (DATA(4).EQ.1.) .OR. (DATA(4).EQ.3.) ) GO TO 9001
IF( (DATA(4).EQ.2.) .AND. (DATA(5).LT.1.) ) GO TO 9001
IF( (DATA(5).GT.1000.) GO TO 9001
IF( (DATA(4).GT.4.) GO TO 9001
IF( (DATA(4).LT.1.) GO TO 9001
IF( (DATA(3).LT.1.) .OR. (DATA(3).GT.44.) ) GO TO 9001
IF( (DATA(4).EQ.4.) .AND. (DATA(5).NE.0.) ) GO TO 9001
IF( (DATA(7).LT.0.) .OR. (DATA(8).LT.0.) ) GO TO 9001
IF( (DATA(4).EQ.4.) GO TO 8000
INDEX=DATA(5)
IF( (IDEV(INDEX).NE.0) GO TO 9005
IDEV(INDEX)=1
GO TO 8000
C
C GET HERE IF DCAB CARD READ
C
4 DO 41 I=1,4
ID=DATA(4)
IF( (ID.EQ.1) GO TO 42
41 CONTINUE
GO TO 9001
42 IF( ((DATA(4).EQ.3.) .OR. (DATA(4).EQ.4.) .AND. (DATA(5).NE.0.) ) GO TO 9001
IF( (DATA(3).LT.1.) .OR. (DATA(3).GT.22.) ) GO TO 9001
IF( ((DATA(4).EQ.1.) .OR. (DATA(4).EQ.2.) .AND. ((DATA(5).LT.1.) .OR. (DATA(5).GT.1000.) ) ) GO TO 9001
IF( (DATA(7).LT.0.) .OR. (DATA(8).LT.0.) ) GO TO 9001
IF( ((DATA(4).EQ.2.) .OR. (DATA(4).EQ.4.) .AND. (DATA(9).NE.0.) ) GO TO 9001
IF( ((DATA(4).EQ.1.) .OR. (DATA(4).EQ.3.) .AND. (DATA(9).LE.0.) ) GO TO 9001
IF( (DATA(10).LT.0.) GO TO 9001
IF( (DATA(4).EQ.3.) .OR. (DATA(4).EQ.4.) ) GO TO 8000
INDEX=DATA(5)
IF( (IDEV(INDEX).NE.0) GO TO 9005
IDEV(INDEX)=1

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      GO TO 8000
C
C GET HERE IF CAB CARD READ
C
      5 INDEX=DATA(3)
      IF( (DATA(3).LT.1.).OR.(DATA(3).GT.22.)) GO TO 9001
      IF( DATA(4).EQ.DATA(5) ) GO TO 9001
      IF( (DATA(4).GT.44.).OR.(DATA(5).GT.44.)) GO TO 9001
      IF( (DATA(4).LT.1.).OR.(DATA(5).LT.1.)) GO TO 9001
      IF( (DATA(7).LE.0.).OR.(DATA(8).LE.0.).OR.(DATA(9).LE.0.)
      1 .OR.(EX.LT.0.).OR.(DATA(10).LT.0.)) GO TO 9001
      IF((DATA(10).EQ.0.).AND.(EX.NE.0.)) GO TO 9001
      IF((DATA(10).NE.0.).AND.(EX.EQ.0.)) GO TO 9001
      IF( INSEG.LT.1).OR.(INSEG.GT.50) ) GO TO 9001
      IF( ICAB(INDEX).NE.0) GO TO 9003
      ICAB(INDEX)=1
      INDEX=DATA(5)
      IF( ICHECK(INDEX).NE.0) GO TO 9002
      ICHECK(INDEX)=1
C
C GET HERE IF DATA OK
C
      INDEX=DATA(3)
      ZJUNC(INDEX)= DATA(4)
      LJUNC(INDEX)= DATA(5)
      51 NNODE(INDEX)= NSEG+1
      WCAB(INDEX)= DATA(6)
      CDCAB(INDEX)=DATA(7)
      DCAB(INDEX)=DATA(8)
      H(INDEX)= DATA(9)/NSEG
      ECICAB(INDEX)= DATA(10)
      EXPCAB(INDEX)= EX
      GO TO 8000
C
C GET HERE IF DEN CARD READ
C
      6 IF(DATA(3).LE.0.) GO TO 9001
      IFRHO=IFRHO+1
      IF( IFRHO.GT.1 ) GO TO 9006
      RHO= DATA(3)
      GO TO 1003
C
C GET HERE IF EOD CARD READ
C
      9 IF EOD=IFEOD+1
      DO 90 J=1,10
      90 DATAT(IROW,J)=DATA(J)
      IRMAX=IROW
      IF(FATE.NE.0.) RETURN
      IF( IFLG.EQ.1) GO TO 91
      GO TO 500
      91 IREAD=ISAV1
      IFLG=0
      GO TO 500
C
C GET HERE IF NJNC CARD READ
C
      10 IF( (DATA(3).LT.2.).OR.(DATA(3).GT.44.)) GO TO 9001
      IFJNC=IFJNC+1

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IF (IFJNC.GT.1) GO TO 9006	INP236
NOJUNC=DATA(3)	INP237
GO TO 1003	INP238
C	INP239
C GET HERE IF NDAT CARD READ	INP240
C	INP241
12 NDATC=NDATC+1	INP242
IF (NDATC.NE.1) GO TO 9018	INP243
GO TO 998	INP244
12701 IFCOMP=0	INP245
INDAT=0	INP246
IFVEL=0	INP247
IFANG=0	INP248
IF ((DATA(3).LT.0.).OR.(DATA(3).GT.2.)) GO TO 9001	INP249
ILOPT=DATA(3)	INP250
IF (NDATC.EQ.1) GO TO 1270	INP251
IF (ILOPT.EQ.0) GO TO 1201	INP252
IF (KFLG.EQ.0) GO TO 1271	INP253
IF (ILOPT.EQ.KCUR) GO TO 1201	INP254
GO TO 9117	INP255
1270 IF (ILOPT.EQ.0) GO TO 1275	INP256
1271 KFLG=1	INP257
KCUR=ILOPT	INP258
GO TO 1201	INP259
1275 KFLG=0	INP260
C	INP261
C READ ONE INPUT RECORD FROM PARAMETRIC STUDY SOURCE DECK	INP262
C	INP263
1201 READ (IREAD,1004) (DATN(I),I=1,10),EXX,NNSEG	INP264
DO 1209 I=1,14	INP265
IF (DATN(2).EQ.TEST(I)) GO TO (9018,1208,1208,1208,1208,9018,1207,	INP266
1 1203,1260,9018,1202,9018,9018,9018),I	INP267
1209 CONTINUE	INP268
CALL SWITCH	INP269
GO TO 9000	INP270
C	INP271
C GET HERE IF VEL CARD READ	INP272
C	INP273
1202 IFVEL=IFVEL+1	INP274
CALL SWITCH	INP275
IF (ILOPT.EQ.0) GO TO 9016	INP276
IF (IFVEL.NE.1) GO TO 1225	INP277
NVSEG=0	INP278
DO 1224 I=1,25	INP279
ZVEL(I)=0.	INP280
1224 VELZ(I)=0.	INP281
1225 NVSEG=NVSEG+1	INP282
IF (NVSEG.GT.25) GO TO 9006	INP283
ZVEL(NVSEG)=DATA(3)	INP284
DO 111 K=1,NVSEG	INP285
IF ((ZVEL(NVSEG).EQ.ZVEL(K)).AND.(K.NE.NVSEG)) GO TO 9006	INP286
111 CONTINUE	INP287
VELZ(NVSEG)=DATA(4)	INP288
GO TO 1201	INP289
C	INP290
C GET HERE IF ANG CARD READ	INP291
C	INP292
1203 IFANG=IFANG+1	INP293
CALL SWITCH	INP294

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IF(IVOPT.EQ.0) GO TO 9018
IF(IFANG.EQ.1)  NANG=0
IF(DATA(4).LE.0.) GO TO 9001
IF( DATA(5).LT.DATA(3) ) GO TO 9001
THETAB=DATA(3)
THETAS= DATA(4)
THETAE= DATA(5)
NANG=NANG+1
IF( NANG.GT.1)  GO TO 9006
GO TO 1201

C
C GET HERE IF COMP CARD READ
C
1207 IFCOMP=IFCOMP+1
CALL SWTCH
IF(IFCOMP.EQ.1) NCOMP=0
IF(DATA(3).LE.0.) GO TO 9001
NCOMP= NCOMP+1
IF( NCOMP.GT.1) GO TO 9006
COMPD=DATA(3)
GO TO 1201

C
C GET HERE IF PARAMETERS ARE BEING CHANGED
C LOCATE RECORD TO BE CHANGED AND BRANCH
C
1208 IF(INDAT.NE.0) GO TO 12081
READ(INTAPE,31) ((DATAT(I,J),J=1,10),I=1,IRMAX)
REWIND INTAPE
INDAT=1
12081 DO 1290 I=1,IRMAX
IROW=I
IF((DATN(1).EQ.DATAT(IROW,1)).AND.(DATN(2).EQ.DATAT(IROW,2)))
1 GO TO 1205
IF(DATAT(IROW,2).EQ.TEST(9)) GO TO 9017
1290 CONTINUE
1205 DO 12051 J=1,10
12051 DATA(J)=DATAT(IROW,J)
DO 1206 I=1,5
IF(DATN(2).EQ.TEST(1)) GO TO (1206,1210,1220,1230,1240),I
1206 CONTINUE

C
C GET HERE IF ANC CARD READ
C
1210 IF(DATA(3).NE.DATN(3)) GO TO 9017
CALL SWTCH
INDEX=DATA(3)
GO TO 22

C
C GET HERE IF DJNC CARD READ
C
1220 DO 1222 I=3,5
IF(DATA(I).NE.DATN(I)) GO TO 9017
1222 CONTINUE
CALL SWTCH
IF((DATA(7).LT.0.).OR.(DATA(8).LT.0.)) GO TO 9001
GO TO 8000

C
C GET HERE IF DCAB CARD READ
C

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1230 IF((DATA(3).NE.DATN(3)).OR.(DATA(5).NE.DATN(5))) GO TO 9017      INP354
DO 1231 I=1,3,2                                                         INP355
F=I                                                                       INP356
G=I+1                                                                     INP357
IF(((DATA(4).EQ.F).OR.(DATA(4).EQ.G)).AND.((DATN(4).EQ.F).OR.(DATN(4).EQ.G))) GO TO 1232 INP358
1231 CONTINUE                                                            INP359
GO TO 9017                                                                INP360
1232 CALL SWITCH                                                         INP361
IF( ((DATA(4).EQ.2.).OR.(DATA(4).EQ.4.)).AND.(DATA(9).NE.0.) )      INP362
1 GO TO 9001                                                            INP363
IF( (DATA(7).LT.0.).OR.(DATA(8).LT.0.) ) GO TO 9001                  INP364
IF( ((DATA(4).EQ.1.).OR.(DATA(4).EQ.3.)).AND.(DATA(9).LE.0.) )      INP365
1GO TO 9001                                                            INP366
IF( DATA(10).LT.0. ) GO TO 9001                                       INP367
GO TO 8000                                                              INP368
C                                                                        INP369
C GET HERE IF CAB CARD READ                                           INP370
C                                                                        INP371
1240 DO 1241 I=3,5                                                      INP372
IF(DATA(I).NE.DATN(I)) GO TO 9017                                       INP373
1241 CONTINUE                                                            INP374
CALL SWITCH                                                             INP375
EX=EXX                                                                    INP376
NSEG=NNSEG                                                                INP377
INDEX=DATA(3)                                                            INP378
IF( (DATA(7).LE.0.).OR.(DATA(8).LE.0.).OR.(DATA(9).LE.0.) )          INP379
1 .OR.(EX.LT.0.).OR.(DATA(10).LT.0.) ) GO TO 9001                     INP380
IF((DATA(10).EQ.0.).AND.(EX.NE.0.)) GO TO 9001                        INP381
IF((DATA(10).NE.0.).AND.(EX.EQ.0.)) GO TO 9001                        INP382
IF( NSEG.LT.1).OR.(NSEG.GT.50) ) GO TO 9001                           INP383
GO TO 51                                                                INP384
C                                                                        INP385
C GET HERE IF EOD CARD READ                                           INP386
C                                                                        INP387
1260 IFEOD=IFEOD+1                                                      INP388
IF(FATE.NE.0.) RETURN                                                  INP389
GO TO 501                                                              INP390
C                                                                        INP391
C GET HERE IF LUN CARD READ                                           INP392
C                                                                        INP393
13 INTAPE=DATA(5)                                                       INP394
IFLG=DATA(6)                                                            INP395
IF((IFLG.LT.0).OR.(IFLG.GT.1)) GO TO 9001                              INP396
ISAV1=DATA(3)                                                           INP397
IF(IFLG.EQ.0) IREAD=DATA(3)                                             INP398
IF(IFLG.EQ.1) IREAD=DATA(7)                                             INP399
OFLG=DATA(8)                                                            INP400
IF((OFLG.LT.0).OR.(OFLG.GT.2)) GO TO 9001                             INP401
IF(OFLG.EQ.0) OUTAPE=DATA(4)                                            INP402
IF(OFLG.NE.0) OUTAPE=DATA(9)                                            INP403
IF((IPRNT.EQ.IREAD).OR.(IPRNT.EQ.INTAPE).OR.((OFLG.NE.0).AND.      INP404
1(IPRNT.EQ.OUTAPE)).OR.(INTAPE.EQ.IREAD).OR.(INTAPE.EQ.OUTAPE).OR. INP405
2(IREAD.EQ.OUTAPE).OR.((IFLG.EQ.1).AND.(IREAD.EQ.ISAV1)))GO TO 9001 INP406
GO TO 1003                                                            INP407
14 IF((IFEOD-NDATC).NE.1) GO TO 9018                                    INP408
IF(OFLG.EQ.0) GO TO 141                                                INP409
WRITE(OUTAPE,142) TEST(14)                                            INP410
142 FORMAT(A4,I4,3E15.8)                                              INP411

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141 WRITE(IPRNT,140)
140 FORMAT(1H1,18HANALYSIS COMPLETED)
    FATE=1.
    RETURN
C
C CHECK TO SEE IF SUSPENDED ARRAY SOURCE DECK COMPLETE
C
500 IF((IFJNC.EQ.0).OR.(IFRHO.EQ.0).OR.(NANC.EQ.0)) GO TO 9007
510 IF(FATE.EQ.0.) GO TO 2000
    RETURN
C
C CHECK TO SEE IF PARAMETRIC STUDY SOURCE DECK COMPLETE
C
501 IF((IVOPT.EQ.0).OR.(IVOPT.EQ.2)) GO TO 5101
    NZL=0
    IF(NVSEG.EQ.0) GO TO 9008
    IF(IFVEL.EQ.0) GO TO 549
C
C SORT VELOCITY PROFILE BY Z-COORDINATE
C
550 DO 555 I=1,NVSEG
    K=I
    DO 555 J=K,NVSEG
    IF(ZVEL(I).LE.ZVEL(J)) GO TO 555
    TEMP=ZVEL(I)
    ZVEL(I)=ZVEL(J)
    ZVEL(J)=TEMP
    TEMP=VELZ(I)
    VELZ(I)=VELZ(J)
    VELZ(J)=TEMP
555 CONTINUE
549 INDEX=ANJUNC(1)
    ZANCM=PJUNC(3,INDEX)
    IF(NANC.EQ.1) GO TO 511
    DO 508 N=2,NANC
    INDEX=ANJUNC(N)
    IF(PJUNC(3,INDEX).LT.ZANCM) ZANCH=PJUNC(3,INDEX)
508 CONTINUE
511 DO 509 N=1,NVSEG
    IF(ZVEL(N).LE.ZANCM) NZL=NZL+1
509 CONTINUE
    IF((NZL.EQ.0).OR.(NANC.EQ.0)) GO TO 9008
5101 IF (INCOMP.EQ.0) GO TO 9008
    IF (INDAT.NE.0) GO TO 4000
505 CONTINUE
    RETURN
C
C CHECK ON CONTINUITY OF CABLE NUMBERING AND COUNT CABLES
C
2000 NCAB=ICAB(22)
    DO 2001 N=1,21
    NCAB=NCAB+ICAB(N)
    J=ICAB(N)-ICAB(N+1)
    IF (J.LT.0) GO TO 9009
2001 CONTINUE
    IF (NCAB.EQ.0) GO TO 9009
C
C CHECK ON CONTINUITY OF JUNCTION NUMBERING AND COUNT JUNCTIONS
C

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2002 NJUNC=ICHECK(44)	INP472
DO 2003 N=1,43	INP473
NJUNC=NJUNC+ICHECK(N)	INP474
J=ICHECK(N)-ICHECK(N+1)	INP475
IF (J.LT.0) GO TO 9010	INP476
2003 CONTINUE	INP477
C	INP478
C CHECK ON CONTINUITY OF DEVICE NUMBERING AND COUNT DEVICES	INP479
C	INP480
2004 NDEV=IDEV(1000)	INP481
DO 2005 N=1,999	INP482
NDEV=NDEV+IDEV(N)	INP483
J=IDEV(N)-IDEV(N+1)	INP484
IF (J.LT.0) GO TO 9011	INP485
2005 CONTINUE	INP486
2007 IF (FATE.EQ.0.) GO TO 3000	INP487
RETURN	INP488
C	INP489
C GET HERE IF ARRAY NUMBERED CORRECTLY	INP490
C CHECK TO SEE IF NIR CONSISTENT	INP491
C	INP492
3000 NIRC=NCAB+NANC-NOJUNC	INP493
IF (NIR.NE.NIRC) GO TO 9013	INP494
3001 IF (FATE.EQ.0.) GO TO 4000	INP495
RETURN	INP496
C	INP497
C GET HERE TO MAKE FINAL CHECK ON INTAPE	INP498
C	INP499
4000 I=1	INP500
4009 DO 4001 J=1,10	INP501
4001 DATA(J)=DATAT(I,J)	INP502
I=I+1	INP503
IF (DATA(2).EQ.TEST(1)) GO TO 4002	INP504
IF (DATA(2).EQ.TEST(3)) GO TO 4003	INP505
IF (DATA(2).EQ.TEST(4)) GO TO 4004	INP506
IF (DATA(2).EQ.TEST(5)) GO TO 4005	INP507
IF (DATA(2).EQ.TEST(9)) GO TO 4006	INP508
GO TO 4009	INP509
C	INP510
C GET HERE FOR IR	INP511
C	INP512
4002 ID1=DATA(3)	INP513
ID2=DATA(4)	INP514
IF ((ID2.GT.NOJUNC).OR.(ID1.LE.NOJUNC).OR.(ID1.GT.NJUNC)) GO TO 9014	INP515
GO TO 4009	INP516
C	INP517
C GET HERE FOR DJNC	INP518
C	INP519
4003 ID=DATA(3)	INP520
IF (ID.GT.NJUNC) GO TO 9014	INP521
GO TO 4009	INP522
C	INP523
C GET HERE FOR DCAB	INP524
C	INP525
4004 ID=DATA(3)	INP526
IF (ID.GT.NCAB) GO TO 9014	INP527
RL=H(ID)*(NNODE(ID)-1)	INP528
IF (DATA(10).GE.RL) GO TO 9014	INP529
GO TO 4009	INP530

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C GET HERE FOR CAB
C
4005 ID=DATA(4)
      IF (ID.GT.NJUNC) GO TO 9014
      GO TO 4009
C
C GET HERE FOR EOD
C
4006 WRITE(INTAPE,31) ((DATAT(I,J),J=1,10),I=1,IRMAX)
      31 FORMAT(F4.0,A4,8E15.8)
      REWIND INTAPE
      IF (INDATC.NE.0) RETURN
      IF (FATE.EQ.0.) GO TO 5000
      RETURN
C
C GET HERE IF ALL OK AND CALCULATE PATH
C K IS CABLE COUNTER
C
5000 K=0
C
C LOOP=1 LOOKING FOR CABLES LEAVING ANCHORS
C
      LOOP=1
C
C JMINP REMEMBERS FIRST VALUE OF K ON A LEVEL OF TREE
C
      JMINP=1
C
C JMAX REMEMBERS NUMBER OF CABLES ON A LEVEL OF TOPOGRAPHIC TREE
C
      JMAX=NANC
      IF (LOOP.EQ.1) GO TO 5002
5001 JMAX=K
      IF ((LOOP.EQ.1).AND.(K.NE.1)) GO TO 9015
      IF ((LOOP.EQ.2).AND.(JMIN.EQ.JMINP)) GO TO 9015
      IF (K.EQ.NCAB) GO TO 5008
      LOOP=2
5002 JMIN=JMINP
      DO 5009 J=JMIN,JMAX
C
C LOOKING FOR CABLES LEAVING A JUNCTION
C
      DO 5007 N=1,NCAB
      GO TO (5003,5004),LOOP
5003 IF (ZJUNC(N).EQ.ANJUNC(J)) GO TO 5005
      GO TO 5007
5004 IPATHJ=PATH(J)
      IF (ZJUNC(N).EQ.LJUNC(IPATHJ)) GO TO 5005
      GO TO 5007
C
C GET HERE IF CABLE N STARTS AT JUNCTION M
C
5005 K=K+1
      PATH(K)=N
      GO TO (5007,5006),LOOP
C
C REMEMBER HERE FIRST VALUE OF K ON TREE LEVEL
C

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5006 IF(JMAX.EQ.(K-1)) JMINP=K	INP590
5007 CONTINUE	INP591
5009 CONTINUE	INP592
GO TO 5001	INP593
5008 CONTINUE	INP594
IF(FATE.NE.0.) RETURN	INP595
WRITE(IPRNT,5010)	INP596
5010 FORMAT(///,5X,18HNO ERRORS DETECTED)	INP597
GO TO 1003	INP598
C	INP599
C PUT DATA INTO DATA ARRAY	INP600
C	INP601
8000 IF(IFEOD.NE.0) GO TO 8003	INP602
IF(((DATA(2).EQ.TEST(3)).OR.(DATA(2).EQ.TEST(4)))	INP603
1.AND.(DATA(5).NE.0.)) GO TO 8001	INP604
GO TO 8003	INP605
8001 ID=DATA(5)	INP606
DO 8002 J=1,10	INP607
DATAT(IROW,J)=DATAT(ID,J)	INP608
8002 DATAT(ID,J)=DATA(J)	INP609
GO TO 8005	INP610
8003 DO 8004 J=1,10	INP611
8004 DATAT(IROW,J)=DATA(J)	INP612
IF(IFEOD.NE.0) GO TO 1201	INP613
8005 IROW=IROW+1	INP614
IF(IROW.LE.2150) GO TO 1003	INP615
WRITE(IPRNT,8006)	INP616
8006 FORMAT(6X,2H17,18X,45HCOMMON/B1/ BOUND EXCEEDED. SEE USERS MANUAL	INP617
1.)	INP618
GO TO 1003	INP619
C	INP620
C THIS SECTION GENERATES ALL ERROR MESSAGES	INP621
C	INP622
9116 FATE=1.	INP623
WRITE(IPRNT,9500) IER,DATA(1),DATA(2)	INP624
9500 FORMAT(6X,12,4X,F4.0,3X,A4)	INP625
IF(IER.LQ.12) GO TO 4009	INP626
IF(IER.EQ.16) RETURN	INP627
IF(NDATC.EQ.0) GO TO 1003	INP628
GO TO 1201	INP629
9000 IER=0	INP630
GO TO 9116	INP631
9001 IER=1	INP632
GO TO 9116	INP633
9002 IER=2	INP634
GO TO 9116	INP635
9003 IER=3	INP636
GO TO 9116	INP637
9004 IER=4	INP638
GO TO 9116	INP639
9005 IER=5	INP640
GO TO 9116	INP641
9006 IER=6	INP642
GO TO 9116	INP643
9007 IER=7	INP644
WRITE(IPRNT,9501) IER,IFUNC,IFRHO,NANC	INP645
9501 FORMAT(6X,12,18X,513)	INP646
FATE=1	INP647
GO TO 510	INP648

9008 IER=14	INP649
FATE=1	INP650
WRITE(IPRNT,9501) IER,NCOMP,IVOPT,NVSEG,NZL,NANG	INP651
GO TO 505	INP652
9009 IER=8	INP653
FATE=1	INP654
WRITE(IPRNT,9502) IER,(ICAB(I),I=1,22)	INP655
GO TO 2002	INP656
9010 IER=9	INP657
FATE=1	INP658
WRITE(IPRNT,9502) IER,(ICHECK(I),I=1,44)	INP659
9502 FORMAT(6X,I2,18X,44I2)	INP660
GO TO 2004	INP661
9011 IER=10	INP662
FATE=1	INP663
WRITE(IPRNT,9504) IER,(IDEV(I),I=1,1000)	INP664
9504 FORMAT(6X,I2,12X,100I1,9(/,20X,100I1))	INP665
GO TO 2007	INP666
9013 IER=11	INP667
FATE=1	INP668
WRITE(IPRNT,9501) IER,NCAB,NANC,NOJUNC,NIRC,NIR	INP669
GO TO 3001	INP670
9014 IER=12	INP671
GO TO 9116	INP672
9015 IER=13	INP673
FATE=1	INP674
WRITE(IPRNT,9507) IER	INP675
GO TO 5008	INP676
9507 FORMAT(6X,I2,18X,94HIMPROPER ARRAY REDUCTION OR JUNCTION NUMBERING	INP677
1. CHECK TREE REPRESENTATION OF ARRAY (SEE ARRAY,/,20X,83HREDUCTION	INP678
2N SECTION OF USERS MANUAL) AGAINST JUNCTION NUMBERING ON ANC AND C	INP679
3AB CARDS.)	INP680
9017 DATA(1)=DATN(1)	INP681
DATA(2)=DATN(2)	INP682
9117 IER=15	INP683
GO TO 9116	INP684
9018 IER=16	INP685
IF(IFEOD.EQ.0) GO TO 9116	INP686
DATA(1)=DATN(1)	INP687
DATA(2)=DATN(2)	INP688
GO TO 9116	INP689
END	INP690



## SUBROUTINE PHSOUT

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C
C THIS ROUTINE GENERATES INFORMATION CONCERNING THE PHYSICAL
C CHARACTERISTICS OF THE STRUCTURAL CABLE ARRAY
C
COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,PHS001
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO,PHS002
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,PHS003
1CDCAB,DCAB,FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,PHS004
2OFLG,NIR,THETAS,THETAE,COMPU,THETAB,NJUNC,RHO,TEST,PHS005
3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,PHS006
4WCAB,IDLV,ICHECK,NDEV,NDATC,PHS007
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44),PHS008
1),PHS009
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22),PHS010
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22),PHS011
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22),PHS012
DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14),PHS013
DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22),PHS014
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000),PHS015
DIMENSION ICHECK(44),PHS016
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG,PHS017
INTEGER PATH,PHS018
REAL IR,IRS,PHS019
WRITE(IPRNT,25),PHS020
25 FORMAT(1H1, 54H PHYSICAL CHARACTERISTICS OF THE STRUCTURAL CABLE ARPHS021
1RAY),PHS022
WRITE(IPRNT,1) NANC,PHS023
1 FORMAT(///,19H NO. OF ANCHORS IS ,I2,//5X,64H JUNCTION NO. X-COOPHS024
1RDINATE Y-COORDINATE Z-COORDINATE),PHS025
DO 2 N=1,NANC,PHS026
INDEX=ANJUNC(N),PHS027
2 WRITE(IPRNT,3) INDEX,(PJUNC(I,INDEX),I=1,3),PHS028
3 FORMAT(10X,I2,4X,3(5X,F10.2,3X)),PHS029
NOJUNC=NCAB+NANC-NIR,PHS030
WRITE(IPRNT,4) NOJUNC,PHS031
4 FORMAT(///,39H NO. OF JUNCTIONS IN ORIGINAL ARRAY IS ,I2),PHS032
WRITE(IPRNT,5) NIR,PHS033
5 FORMAT(///,39H NO. OF CUTS MADE IN ORIGINAL ARRAY IS ,I2//1H ,2(5X,PHS034
112H JUNCTION NO.),//8X,6H OF CUT,6X,17H AT WHICH CUT MADE),PHS035
IF(NIR.EQ.0) GO TO 3C,PHS036
DO 6 N=1,NIR,PHS037
6 WRITE(IPRNT,7) IRJUNC(N),ERJUNC(N),PHS038
7 FORMAT(10X,I2,15X,I2),PHS039
30 WRITE(IPRNT,8) NCAB,PHS040
8 FORMAT(///,18H NO. OF CABLES IS ,I2,//5X,16H CABLE S=0 S=L,43X,4H,PHS041
1DRAG,19X,22H CONSTITUTIVE NO. OF,//6X,3H NO.,1X,2(2X,4H JUNC),3X,PHS042
26H LENGTH,03X,8H DIAMETER,3X,13H WEIGHT/LENGTH,3X,11H COEFFICIENT,3X,PHS043
38H RIGIDITY,6X,8H EXPONENT,5X,8H ELEMENTS),PHS044
DO 9 N=1,NCAB,PHS045
NSEG=NNODE(N)-1,PHS046
RL=H(N)*NSEG,PHS047
9 WRITE(IPRNT,10) N,ZJUNC(N),LJUNC(N),RL,DCAB(N),WCAB(N),CDCAB(N),PHS048
1ECICAB(N),EXPCAB(N),NSEG,PHS049
10 FORMAT(6X,I2,5X,I2,4X,I2,1X,F9.1,3(3X,F7.3,4X), F10.0,7X,F6.3,PHS050
19X,I2),PHS051
WRITE(IPRNT,11),PHS052
11 FORMAT(///,63H PROPERTIES OF THE DEVICES LOCATED AT JUNCTIONS ARE APHS053
15 FOLLOWS ,//6X,6H DEVICE,10X,6H DEVICE,9X,11H DEVICE DRAG,4X,14H DEVIPHS054

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2CE FRONTAL,/,5X,9HJUNC. NO.,8X,6HWEIGHT,9X,11HCOEFFICIENT,9X,
34HAREA)
12 READ(NTAPE,13) (DATA(I),I=1,10)
13 FORMAT(F4.0,A4,8E15.8)
   IF(DATA(2).EQ.TEST(3)) GO TO 14
   IF(DATA(2).EQ.TEST(9)) GO TO 16
   GO TO 12
14 JUNC=DATA(3)
   WRITE(IPRNT,15) JUNC,(DATA(K),K=6,8)
15 FORMAT(8X,12,9X,F10.2,6X,F10.3,6X,F10.2)
   GO TO 12
16 REWIND INTAPE
   WRITE(IPRNT,24) NDEV
24 FORMAT(///,32H TOTAL NO. OF INDEXED DEVICES IS,14)
   WRITE(IPRNT,17) IVOPT
17 FORMAT(///,25H CURRENT FIELD OPTION IS ,11)
   IV=IVOPT+1
   GO TO (22,18,22),IV
18 WRITE(IPRNT,19)
19 FORMAT(//7X12HZ-COORDINATE,6X,11HVELOCITY OF,/,8X,10HOF CURRENT,7X,
112HCURRENT AT Z)
   DO 20 N=1,NVSEG
20 WRITE(IPRNT,21) ZVEL(N),VELZ(N)
21 FORMAT(2X,5X,F10.2,10X,F7.2)
22 WRITE(IPRNT,23) COMPD
23 FORMAT(///,38H ACCURACY REQUIRED IN CALCULATIONS IS ,F6.2)
   IF(OFLG.NE.0) WRITE(IPRNT,111) NDATE
111 FORMAT(///,30H DEVICE LOCATION OUTPUT RECORD,13,21H REFERS TO THIS
1ARRAY )
   RETURN
   END

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PHS060  
PHS061  
PHS062  
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PHS081  
PHS082  
PHS083  
PHS084  
PHS085  
PHS086  
PHS087  
PHS088  
PHS089  
PHS090

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SUBROUTINE STROUT
C
C THIS ROUTINE GENERATES THE ARRAY STRUCTURAL OUTPUT
C
COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,
1CDCAB,DCAB,FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,
2OFLG,NIR,THETAS,THETA,COMP,THETAB,NJUNC,RHO,TEST,
3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,
4WCAB,IDEV,ICHECK,NDEV,NDATC
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44)
1)
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22)
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22)
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22)
DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14)
DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22)
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000)
DIMENSION ICHECK(44)
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
INTEGER PATH
REAL IR,IRS
DIMENSION TEMP1(3),TEMP2(3),TEMP3(3),DISP(3),PSPACE(3)
DIMENSION A(3),B(3),D(3),U(3),V(3),W(3),C(4),RQ(3),RI(3)
NOJUNC=NCAB+NANC-NIR
JUM=JUMP+1
GO TO(100,200),JUM
100 WRITE(IPRNT,1002)
1002 FORMAT(1H,35HARRAY EQUILIBRIUM WITH NO CURRENT ///)
GO TO 300
200 WRITE(IPRNT,1001) THETA
1001 FORMAT(1H,35HARRAY EQUILIBRIUM WITH CURRENT FROM,F8.2, 9H DEGREES
1 ///)
C
C GENERATE ANCHOR HEADERS
C
300 WRITE(IPRNT,1003)
1003 FORMAT(1H,13HARRAY ANCHORS )
WRITE(IPRNT,10031)
10031 FORMAT(1H,13H-----//)
WRITE(IPRNT,1004)
1004 FORMAT(1H, 32HJUNC. NO. CABLE AT TENSION AT ,14X,26HFORCE C
10MPONENTS AT ANCHOR,13X,16HCABLE ANGLES WRT)
WRITE(IPRNT,1005)
1005 FORMAT(1H,30HOF ANCHOR ANCHOR ANCHOR8X,6HX-COMP,6X,6HY-COMSTR
1P,6X,6HZ-COMP,3X,9HHOR.-COMP,5X,16HX-AXIS XY-PLANE)
C
C THIS SECTION CALCULATES FORCES AND ANGLES AT ANCHORS
C
DO 401 J1=1,NANC
J3=0
402 J2=1
404 IF (ANJUNC(J1).EQ.ZJUNC(J2)) GO TO 403
414 J2=J2+1
IF(J2.LE.NCAB) GO TO 404
IF(NIR.EQ.0) GO TO 401
412 J3=1
411 IF(ANJUNC(J1).EQ.ERJUNC(J3)) GO TO 405

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STR003  
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STR058  
STR059

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413 J3=J3+1
    IF(J3.LE.NIR) GO TO 411
    GO TO 401
405 INDEX=1RJUNC(J3)
    DO 406 J4=1,NCAB
    IF(INDLX.EQ.LJUNC(J4)) GO TO 407
406 CONTINUE
    GO TO 401
407 MM=J4
    MX=NNODE(J4)
    T=TCAB(MX,MM)
    RX=-RCAB(1,MX,MM)
    RY=-RCAB(2,MX,MM)
    RZ=-RCAB(3,MX,MM)
    GO TO 408
403 MM=J2
    T=TCAB(1,MM)
    RX=RCAB(1,1,MM)
    RY=RCAB(2,1,MM)
    RZ=RCAB(3,1,MM)
408 RH=SQRT(RX**2 + RY**2)
    A1=ASIN(RY/RH)/PI
    A2=ASIN(RZ/T)/PI
    IF((RX.LT.0.).AND.(RY.GE.0.)) A1=180.-A1
    IF((RX.LT.0.).AND.(RY.LT.0.)) A1=-180.-A1
    WRITE(1PRNT,1005) ANJUNC(J1),MM,T,RX,RY,RZ,RH,A1,A2
1006 FORMAT(1H,3X,12,9X,12,5X,F10.1,3X,4(F10.1,2X),2(2X,F7.2,1X))
    IF(J2.LT.NCAB) GO TO 414
    IF( (J2.EQ.NCAB).AND.(J3.EQ.0) ) GO TO 412
    IF( (J2.EQ.NCAB).AND.(J3.NE.NJUNC) ) GO TO 413
401 CONTINUE
C
C GENERATE CABLE HEADERS
C
    WRITE(1PRNT,2000)
2000 FORMAT(1H,///1H,12HARRAY CABLES )
    WRITE(1PRNT,2001)
2001 FORMAT(1H,12H-----/)
    WRITE(1PRNT,2002)
2002 FORMAT(1H,120HCABLE MAXIMUM S-COORD MINIMUM S-COORD MAXIMUM
1 S-COORD LOCATION OF THIS POINT NO CURRENT LOC. OF THIS POS
2INT )
    WRITE(1PRNT,2003)
2003 FORMAT(1H,120H NO. TENSION OF TENSION OF DISP.
1 OF X-COORD Y-COORD Z-COORD X-COORD Y-COORD Z-COORD
2RD )
C
C THIS SECTION CALCULATES MAXIMUM AND MINIMUM CABLE TENSIONS
C AND MAXIMUM CABLE DISPLACEMENTS FROM NO CURRENT LOCATION
C BY EXTRAPOLATION BETWEEN CABLE NODES
C
C INITIALIZE EXTREMA
C
    DO 799 NN=1,NCAB
    N=NN
    TMAX=TCAB(1,N)
    STMAX=0.
    TMIN=IMAX
    STMIN=0.

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      GO TO (802,801),JUM
801  DMAX=0.
      DO 700 I=1,3
800  DMAX=DMAX+(PCAB(I,1,N)-PCABO(I,1,N))*2
      DMAX=SQRT(DMAX)
      SDMAX=0.
802  MX=NNODE(N)-1
      DO 750 MM=1,MX
      M=MM
      M1=MM+1
C
C  CALCULATE EXTRAPOLATION QUANTITIES
C
      RR=0.
      RD=0.
      DD=0.
      DO 701 I=1,3
      D(I)=(RCAB(I,M1,N)-RCAB(I,M,N))/H(N)
      GO TO (804,803),JUM
803  A(I)=EXCAB(M,N)*RCAB(I,M,N)/TCAB(M,N)
      B(I)=(EXCAB(M1,N)*RCAB(I,M1,N)/TCAB(M1,N)-A(I))/H(N)
      U(I)=PCAB(I,M,N)-PCABO(I,M,N)
804  RR=RR+RCAB(I,M,N)*RCAB(I,M,N)
      RD=RD+RCAB(I,M,N)*D(I)
801  DD=DD+D(I)*D(I)
      GO TO (806,805),JUM
805  DO 702 I=1,3
      TEMP1(I)=RCAB(I,M,N)
      TEMP2(I)=RCAB(I,M1,N)
      RCAB(I,M,N)=RCABO(I,M,N)
802  RCAB(I,M1,N)=RCABO(I,M1,N)
      UU=0.
      UV=0.
      UVW=0.
      VW=0.
      WW=0.
      DO 703 I=1,3
      V(I)=EXCAB(M,N)*RCAB(I,M,N)/TCAB(M,N)
      W(I)=(EXCAB(M1,N)*RCAB(I,M1,N)/TCAB(M1,N)-V(I))/H(N)
      VI(I)=A(I)-V(I)
      WI(I)=(B(I)-W(I))/2.
      UU=UU+U(I)*U(I)
      UV=UV+U(I)*V(I)
      UVW=UVW+2.*U(I)*W(I)+V(I)*V(I)
      VW=VW+V(I)*W(I)
803  WW=WW+W(I)*W(I)
      DO 704 I=1,3
      RCAB(I,M,N)=TEMP1(I)
804  RCAB(I,M1,N)=TEMP2(I)
806  C(4)=0.
      C(3)=0.
      C(2)=DD
      C(1)=RD
      CALL KPCOLY(C,RD,RI)
C
C  CALCULATE TENSION EXTREMA IN SEGMENT
C
      JTIME=0
      DO 719 I=1,3

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      IF( RI(1).NE.0.) GO TO 719
      IF((RQ(1).LE.0.)OR.(RQ(1).GE.H(N))) GO TO 719
      SIG=RQ(1)
710  TE=SQRT(RR+2.*RD*SIG+DD*SIG**2)
      IF(TE.GT.TMAX) GO TO 712
      IF(TE.LT.TMIN) GO TO 713
711  IF(JTIME.EQ.0) GO TO 719
      GO TO 715
712  TMAX=TE
      STMAX=H(N)*(M-1)+SIG
      GO TO 711
713  TMIN=TE
      STMIN=H(N)*(M-1)+SIG
      GO TO 711
719  CONTINUE
      JTIME=1
      SIG=H(N)
      GO TO 710
715  GO TO(750,716),JUM
716  C(4)=2.*WW
      C(3)=3.*VW
      C(2)=UVW
      C(1)=1
      CALL RPOLY(C,RQ,RI)
C
C CALCULATE MAXIMUM DISPLACEMENT IN SEGMENT
C
      JTIME=0
      DO 729 I=1,3
      IF (RI(I).NE.0.) GO TO 729
      IF((RQ(I).LE.0.)OR.(RQ(I).GE.H(N))) GO TO 729
      SIG=RQ(I)
720  DE=SQRT(UU+2.*UV*SIG+UVW*SIG**2+2.*VW*SIG**3+WW*SIG**4)
      IF(DE.GT.DMAX) GO TO 722
721  IF(JTIME.EQ.0) GO TO 729
      GO TO 750
722  DMAX=DE
      SDMAX= H(N)*(M-1)+SIG
      GO TO 721
729  CONTINUE
      JTIME=1
      SIG=H(N)
      GO TO 720
750  CONTINUE
C
C EXTREMA ALONG A CABLE NOW DETERMINED
C CALCULATE FINAL AND INITIAL COORDINATES OF MAXIMALLY DISPLACED POINT
C
      GO TO (810,809),JUM
809  RL=H(N)*MX
      IF(SDMAX.LT.RL) GO TO 760
      K=LJUNC(N)
      DO 751 I=1,3
      A(I)=PJUNC(I,K)
751  B(I)=PJUNC(I,K)
      GO TO 780
760  DATA(2)=TEST(4)
      DATA(3)=N
      DATA(10)=SDMAX

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J=(SDMAX/H(N))+1
J1=J+1
DO 761 I=1,3
  I=I1
761 A(I)=SPACE(I)
  DO 762 I=1,3
    TEMP1(I)=RCAB(I,J,N)
    TEMP2(I)=RCAB(I,J1,N)
    TEMP3(I)=PCAB(I,J,N)
    RCAB(I,J,N)=RCABO(I,J,N)
    RCAB(I,J1,N)=RCABO(I,J1,N)
762 PCAB(I,J,N)=PCABO(I,J,N)
  DO 763 I=1,3
    I=I1
763 B(I)=SPACE(I)
  DO 764 I=1,3
    RCAB(I,J,N)=TEMP1(I)
    RCAB(I,J1,N)=TEMP2(I)
764 PCAB(I,J,N)=TEMP3(I)
780 CONTINUE
  WRITE(IPRNT,781)N,TMAX,STMAX,TMIN,STMIN,DMAX,SDMAX,(A(I),I=1,3),
  1 B(I),I=1,3)
  GO TO 799
810 WRITE(IPRNT,781)N,TMAX,STMAX,TMIN,STMIN
781 FORMAT(1H ,I4,1X,6F9.1,6F10.1)
799 CONTINUE

C
C GENERATE JUNCTION HEADERS
C
  WRITE(IPRNT,1007)
1007 FORMAT(1H ///1H ,15HARRAY JUNCTIONS)
  WRITE(IPRNT,10071)
10071 FORMAT(1H ,15H----- / )
  WRITE(IPRNT,1008)
1008 FORMAT(1H ,27HJUNC. CABLE AT TENSION AT,3X,16HCABLE ANGLES WRT,
110X,17HJUNCTION LOCATION,10X,33HDISPLACEMENT FROM NO CURRENT LOC.)
  WRITE(IPRNT,1009)
1009 FORMAT(1H ,15H NO. JUNCTION3X,8HJUNCTION4X,16HX-AXIS XY-PLANE,
168H X-COORD Y-COORD Z-COORD X-DISP Y-DISP Z-STR275
2DISP )
C
C THIS SECTION CALCULATES JUNCTION FORCES, LOCATIONS AND DISPLACEMENTS
C
  IF=0
  DO 601 J1=1,NOJUNC
  DO 605 K=1,NANC
  IF(ANJUNC(K).EQ.J1) GO TO 601
605 CONTINUE
  GO TO (602,603),JUM
603 DO 604 J2=1,3
604 DISP(J2)=PJUNC(J2,J1)-PJUNC0(J2,J1)
602 J6=1
608 IF(J1.EQ.2JUNC(J6)) GO TO 606
615 IF(J1.EQ.LJUNC(J6)) GO TO 607
617 J6=J6+1
  IF(J6.LE.NCAB) GO TO 608
  IF(NIR.LO.0) GO TO 601
  J7=1
609 IF(J1.EQ.ERJUNC(J7)) GO TO 610

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616 J7=J7+1
    IF (J7.LE.NIR) GO TO 609
    GO TO 601
606 MM=J6
    T=TCAB(1,MM)
    RX=RCAB(1,1,MM)
    RY=RCAB(2,1,MM)
    RZ=RCAB(3,1,MM)
    GO TO 611
610 INDEX=IRJUNC(J7)
    DO 612 J8=1,NCAB
    IF (INDEX.EQ.LJUNC(J8)) GO TO 613
612 CONTINUE
613 MM=J8
    GO TO 614
607 MM=J6
614 MX=NNODE(MM)
    T=TCAB(MX,MM)
    RX=-RCAB(1,MX,MM)
    RY=-RCAB(2,MX,MM)
    RZ=-RCAB(3,MX,MM)
611 RH=SQRT(RX**2+RY**2) IF (RH.EQ.0) RH=1.
    A1=ASIN(RY/RH)/PI
    A2=ASIN(RZ/T)/PI
    IF ((RX.LT.0.).AND.(RY.GE.0.)) A1=180.-A1
    IF ((RX.LT.0.).AND.(RY.LT.0.)) A1=-180.-A1
    IF ((IF.EQ.0).AND.(JUM.EQ.1)) WRITE(IPRNT,620) J1,MM,T,A1,A2,(PJUNC
1(K,J1),K=1,3)
    IF ((IF.LQ.0).AND.(JUM.LQ.2)) WRITE(IPRNT,620) J1,MM,T,A1,A2,(PJUNC
1(K,J1),K=1,3), (DISP(I),I=1,3)
    IF (IF.EQ.1) WRITE(IPRNT,620) J1,MM,T,A1,A2
    IF=1
620 FORMAT(1H ,I4,6X,I2,4X,F10.1,3X,F7.2,3X,F7.2,3(1X,F10.1),1X,3(1X,
1F10.1))
    IF ((J6.LT.NCAB).AND.(J1.EQ.ZJUNC(J6))) GO TO 615
    IF ((J6.LT.NCAB).AND.(J1.EQ.LJUNC(J6))) GO TO 617
601 IF=0
C
C GENERATE INDEXED DEVICE HEADERS
C
    WRITE(IPRNT,519)
519 FORMAT(1H ,///1H ,34HINDEXED DEVICES ALONG ARRAY CABLES )
    WRITE(IPRNT,5191)
5191 FORMAT(1H ,34H----- - - - - - * /)
    WRITE(IPRNT,520)
520 FORMAT(1H ,7HDEVICE ,5HCABLE,6X,1HS,7X,10HTENSION AT,13X,15HDEVICE
1 LOCATION,12X,36H DISPLACMENT FROM NO CURRENT LOC. )
    WRITE(IPRNT,521)
521 FORMAT(1H ,109HINDEX NO. COORDINATE DEVICE X-COORD
1 Y-COORD Z-COORD X-DISP Y-DISP Z-DISP)
C
C THIS SECTION CALCULATES TENSIONS AT INDEXED DEVICES,
C DEVICE LOCATIONS, AND DEVICE DISPLACEMENTS
C
    IF (NDEV.EQ.0) GO TO 511
    DO 510 N=1,NDEV
    READ (INTAPE,501) (DATA(I),I=1,10)
501 FORMAT (14,A4,8E15.8)
    IF (DATA(2).LQ.TEST(3)) GO TO 510

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K=DATA(3)
M=DATA(10)/H(K) + 1
INDEX=DATA(5)
SIGMA=DATA(10)-(M-1)*H(K)
TEN2=0.
DO 502 I=1,3
  I=11
  PSPACE(I)=SPACE(I)
502 TEN2=TEN2+(RCAB(I,M,K)+(RCAB(I,M+1,K)-RCAB(I,M,K))*SIGMA/H(K))**2
  TEN=SQRT(TEN2)
  GO TO (503,505),JUM
503 WRITE (IPRNT,509) INDEX,K,DATA(10),TEN,(PSPACE(I),I=1,3)
  GO TO 510
505 DO 506 I=1,3
  TEMP1(I)=RCAB(I,M,K)
  TEMP2(I)=RCAB(I,M+1,K)
  TEMP3(I)=PCAB(I,M,K)
  RCAB(I,M,K)=RCABO(I,M,K)
  RCAB(I,M+1,K)=RCABO(I,M+1,K)
506 PCAB(I,M,K)=PCABO(I,M,K)
  DO 507 I=1,3
  I=11
507 DISP(I)=PSPACE(I)-SPACE(I)
  DO 508 I=1,3
  RCAB(I,M,K)=TEMP1(I)
  RCAB(I,M+1,K)=TEMP2(I)
508 PCAB(I,M,K)=TEMP3(I)
  WRITE (IPRNT,509) INDEX,K,DATA(10),TEN,(PSPACE(I),I=1,3),
  1(DISP(I),I=1,3)
509 FORMAT(1H ,I4,4X,I2,4X,F9.1,3X,F9.1,1X,3(2X,F10.1),4X,3(1X,F10.1))
510 CONTINUE
511 REWIND INTAPE
RETURN
END
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## SUBROUTINE TAPOUT

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C
C THIS ROUTINE GENERATES THE TAPE OR CARDS GIVING
C THE LOCATIONS OF THE INDEXED DEVICES
C
COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,
1CDCAB,DCAB,FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,
2OFLG,N1-,THETAS,THETA,COMP,THETAB,ANJUNC,RHO,TEST,
3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,
4WCAB,IDEV,ICHECK,NDEV,NDATC
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44)
1)
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22)
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22)
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22)
DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14)
DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22)
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000)
DIMENSION ICHECK(44)
DIMENSION PSPACE(3)
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
INTEGER PATH
REAL IR,IRS
ID1=4H CUR
ID2=4H DEV
ID3=4H REC
1 FORMAT(A4,I4,3F10.2)
JUM=JUMP+1
GO TO (2,3) JUM
2 WRITE(OUTAPE,1) ID3,NDATC
WRITE(OUTAPE,1) ID1,JUMP
GO TO 4
3 WRITE(OUTAPE,1) ID1,JUMP,THETA
4 IF (NDEV.EQ.0) GO TO 8
DO 7 NN=1,NDEV
READ(INTAPE,5) (DATA(K),K=1,10)
5 FORMAT(F4.0,A4,8E15.8)
INDEX=DATA(5)
C
C CALCULATE LOCATION OF DEVICE IN SPACE
C
DO 6 J=1,3
I=J
6 PSPACE(I)=SPACE(I)
WRITE(OUTAPE,1) ID2,INDEX,(PSPACE(I),I=1,3)
7 CONTINUE
8 CONTINUE
REWIND +NTAPE
RETURN
END

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## SUBROUTINE ERROR

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C
C THIS ROUTINE GENERATES A TYPE 18 ERROR MESSAGE
C GET HERE IF ALL IMAGINARY REACTIONS DO NOT CHANGE
C
COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,ERR001
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNC,ERR002
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,ERR003
1CDCAB,DCAB,FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,ERR004
2OFLG,NIR,THETAS,THETA,COMP,THETA,ANJUNC,RHO,TEST,ERR005
3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,ERR006
4WCAB,IDEV,ICHECK,NDEV,NDATC,ERR007
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNC(3,44),ERR008
1)ERR009
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22),ERR010
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22),ERR011
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22),ERR012
DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14),ERR013
DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22),ERR014
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000),ERR015
DIMENSION ICHECK(44),ERR016
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG,ERR017
INTEGER PATH,ERR018
REAL IR,IRS,ERR019
E=E*10.,ERR020
WRITE(IPRNT,1),ERR021
1 FORMAT(1H1,52H TYPE 18 ERROR. STRUCTURAL ANALYSIS NOT COMPLETED,ERR022
1/60H PRINTOUT GIVEN FOR DIAGNOSTIC PURPOSES. SEE USERS MANUAL./)ERR023
JUM=JUMP+1,ERR024
GO TO (4,6),JUM,ERR025
4 WRITE(IPRNT,5),ERR026
5 FORMAT(5X,40HEXISTING CURRENT CONDITION IS NO CURRENT /),ERR027
GO TO 6,ERR028
6 WRITE(IPRNT,7) THETA,ERR029
7 FORMAT(5X,38HEXISTING CURRENT CONDITION IS THETA = ,F3.0/),ERR030
8 WRITE(IPRNT,9) E,ERR031
9 FORMAT(5X,35HBEST VALUE OF ACCURACY OBTAINED IS ,F6.2),ERR032
DO 2 N=1,NCAB,ERR033
NN=N,ERR034
WRITE(IPRNT,10) NN,ERR035
10 FORMAT(//5X,29HTHE TENSIONS IN CABLE NUMBER ,I2,4H ARE,/),ERR036
L=NNODE(N),ERR037
DO 2 M=1,L,ERR038
MM=M,ERR039
T=TCAB(MM,NN),ERR040
S=H(NN)*(MM-1.),ERR041
2 WRITE(IPRNT,3) T,S,ERR042
3 FORMAT(7X,2HT=,F10.2,6H AT S=,F10.2),ERR043
RETURN,ERR044
END,ERR045
ERR046
ERR047
ERR048
ERR049
ERR050

```

## SUBROUTINE RPOLY(C,RR,RI)

```

C
C THIS ROUTINE FINDS REAL ROOTS OF POLYNOMIAL EQUATIONS UP TO
C  $C(4)*(X**3) + C(3)*(X**2) + C(2)*X + C(1) = 0$  FOR USE IN
C EVALUATING MAXIMUM CABLE DISPLACEMENTS AND TENSION EXTREMA
C
C REAL PARTS OF ROOTS ARE PLACED IN RR, IMAGINARY PARTS IN RI
C SINCE ONLY REAL ROOTS ARE OF INTEREST, ALL NON-REAL OR
C NON-EXISTING ROOTS RETURN RR=0, RI=1
C

```

```

      DIMENSION C(4),RR(3),RI(3)
      IF(C(4).NE.0.) GO TO 30
      IF(C(3).NE.0.) GO TO 20
      IF(C(2).NE.0.) GO TO 10

```

```

C
C GET HERE IF EQUATION IDENTICALLY SATISFIED
C

```

```

      100 DO 1 I=1,3
          RR(I)=0.
          1 RI(I)=1.
          RETURN

```

```

C
C GET HERE IF EQUATION LINEAR
C

```

```

      10 RR(1)=-C(1)/C(2)
          RI(1)=0.
      200 DO 11 I=2,3
          RR(I)=0.
          11 RI(I)=1.
          RETURN

```

```

C
C GET HERE IF EQUATION QUADRATIC
C

```

```

      20 DISC=C(2)**2-4.*C(1)*C(3)
          IF(DISC.GE.0.) GO TO 21
          GO TO 100
      21 RR(1)=(-C(2)+SQRT(DISC))/(2.*C(3))
          RI(1)=0.
          RR(2)=(-C(2)-SQRT(DISC))/(2.*C(3))
          RI(2)=0.
          RR(3)=0.
          RI(3)=1.
          RETURN

```

```

C
C GET HERE IF EQUATION CUBIC
C

```

```

      30 P=C(3)/C(4)
          Q=C(2)/C(4)
          R=C(1)/C(4)
          A=(3.*Q-P**2)/3.
          B=(2.*P**3-9.*P*Q+27.*R)/27.
          DISC= (B**2)/4.+(A**3)/27.
          IF(DISC)32,31,31
      31 DISC= SQRT(DISC)
          CAPA=(((-B/2.+DISC)**4)**(1./3.))/(-B/2.+DISC)
          CAPB=(((-B/2.-DISC)**4)**(1./3.))/(-B/2.-DISC)
          RR(1)=CAPA+CAPB-P/3.
          RI(1)=0.
          IF(DISC.GT.0.) GO TO 200

```

```

RP0001
RP0002
RP0003
RP0004
RP0005
RP0006
RP0007
RP0008
RP0009
RP0010
RP0011
RP0012
RP0013
RP0014
RP0015
RP0016
RP0017
RP0018
RP0019
RP0020
RP0021
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RP0023
RP0024
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RP0031
RP0032
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RP0034
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RP0036
RP0037
RP0038
RP0039
RP0040
RP0041
RP0042
RP0043
RP0044
RP0045
RP0046
RP0047
RP0048
RP0049
RP0050
RP0051
RP0052
RP0053
RP0054
RP0055
RP0056
RP0057
RP0058
RP0059

```

```

RR(2)=-CAPA-P/3.
RI(2)=0.
RR(3)=RK(2)
RI(3)=0.
RETURN
32 DISC=2.*SQRT(-A/3.)
PHI=ACOS((1+3.*B)/(A*DISC))/3.
RR(1)=-P/3.+DISC*COS(PHI)
RR(2)=-P/3.+DISC*COS(PHI+3.14159265*(2./3.))
RR(3)=-P/3.+DISC*COS(PHI+3.14159265*(4./3.))
RI(1)=0.
RI(2)=0.
RI(3)=0.
RETURN
END

```

```

RPO060
RPO061
RPO062
RPO063
RPO064
RPO065
RPO066
RPO067
RPO068
RPO069
RPO070
RPO071
RPO072
RPO073
RPO074

```

```

C SUBROUTINE SWITCH
C THIS ROUTINE SWITCHES INPUT DATA
C

```

```

COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,SWT001
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO,SWT002
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,SWT003
1CDCAB,DCAE,FATE,NANG,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,SWT004
2OFLG,NIR,THETAS,THETA,COMP,THETAB,NJUNC,RHO,TEST,SWT005
3NVSEG,ZVEL,VELZ,PIP,LCICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,SWT006
4WCAB,IDEV,ICHECK,NDEV,NDATC,SWT007
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44),SWT008
1),SWT009
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22),SWT010
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22),SWT011
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22),SWT012
DIMENSION PJUNC(3,44),CDCAB(22),DCAE(22),ANJUNC(44),TEST(14),SWT013
DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22),SWT014
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000),SWT015
DIMENSION ICHECK(44),SWT016
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG,SWT017
INTEGER PATH,SWT018
REAL IR,IRS,SWT019
DO 1 I=1,10,SWT020
1 DATA(I)=DATN(I),SWT021
RETURN,SWT022
END,SWT023
,SWT024
,SWT025
,SWT026
,SWT027

```

## SUBROUTINE START

```

C THIS ROUTINE CALCULATES THE INITIAL GUESSES AT THE IMAGINARY
C AND EQUILIBRATING REACTIONS AND THE INITIAL DELTA BASED ON
C THE TOTAL WEIGHT OF THE ARRAY
C
COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,
1CDCAB,DCAB,FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,
2OFLG,NIR,THETAS,THETAE,COMPD,THETAB,NJUNC,RHO,TEST,
3NVSEG,ZVEL,VELZ,PIP,ECICAB,LXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,
4WCAB,IDEV,ICHECK,NDEV,NDATC
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44)
1)
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22)
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22)
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22)
DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14)
DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22)
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000)
DIMENSION ICHECK(44)
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
INTEGER PATH
REAL IR,IRS
WEIGHT=0.
DO 1 J=1,NJUNC
1 WEIGHT=WEIGHT+FEJUNC(3,J)
DO 2 N=1,NCAB
INNN=NNODE(N)-1
DO 2 M=1,INNN
2 WEIGHT=WEIGHT+ FCAB(3,M,N)
DO 3 N=1,NIR
KER=ERJUNC(N)
DO 3 I=1,3
3 IR(1,KER)=0.
DO 4 N=1,NIR
KIR=IRJUNC(N)
KER=ERJUNC(N)
IR(1,KIR)=0.
IR(2,KIR)=0.
IR(3,KIR)=-WEIGHT/(NIR+1.101)
4 IR(3,KER)=IR(3,KER)-IR(3,KIR)
DELTA1= ABS(WEIGHT)/(NIR+1)
RETURN
END

```

STA001  
 STA002  
 STA003  
 STA004  
 STA005  
 STA006  
 STA007  
 STA008  
 STA009  
 STA010  
 STA011  
 STA012  
 STA013  
 STA014  
 STA015  
 STA016  
 STA017  
 STA018  
 STA019  
 STA020  
 STA021  
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 STA023  
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 STA027  
 STA028  
 STA029  
 STA030  
 STA031  
 STA032  
 STA033  
 STA034  
 STA035  
 STA036  
 STA037  
 STA038  
 STA039  
 STA040  
 STA041  
 STA042  
 STA043  
 STA044  
 STA045  
 STA046

```

FUNCTION TCAB(M,K)
C
C THIS ROUTINE CALCULATES THE TENSION AT NODE M OF CABLE K
C
COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,
1CDCAB,DCAB,FATE,NANG,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,
2OFLG,NIR,THETAS,THETA,COMPU,THETAB,NJUNC,RHO,TEST,
3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,
4WCAB,IDEV,ICHECK,NDEV
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44)
1)
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22)
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22)
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22)
DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14)
DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22)
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000)
DIMENSION ICHECK(44)
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
INTEGER PATH
REAL IR,IRS
TCAB =SQRT(RCAB(1,H,K)**2 + RCAB(2,M,K)**2 + RCAB(3,M,K)**2 )
RETURN
END

```

TCA001  
TCA002  
TCA003  
TCA004  
TCA005  
TCA006  
TCA007  
TCA008  
TCA009  
TCA010  
TCA011  
TCA012  
TCA013  
TCA014  
TCA015  
TCA016  
TCA017  
TCA018  
TCA019  
TCA020  
TCA021  
TCA022  
TCA023  
TCA024  
TCA025  
TCA026

```

FUNCTION EXCAB(M,K)
C
C THIS ROUTINE CALCULATES (1 + STRAIN) AT NODE M OF CABLE K
C
COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,
1CDCAB,DCAB,FATE,NANG,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,
2OFLG,NIR,THETAS,THETA,COMPU,THETAB,NJUNC,RHO,TEST,
3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,
4WCAB,IDEV,ICHECK,NDEV,NDATC
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44)
1)
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22)
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22)
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22)
DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14)
DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22)
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000)
DIMENSION ICHECK(44)
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
INTEGER PATH
REAL IR,IRS
IF(EXPCAB(K).EQ.0.) GO TO 1
EXCAB=1.+(TCAB(M,K)/LCICAB(K))*EXPCAB(K)
RETURN
1 EXCAB=1.
RETURN
END

```

EXC001  
EXC002  
EXC003  
EXC004  
EXC005  
EXC006  
EXC007  
EXC008  
EXC009  
EXC010  
EXC011  
EXC012  
EXC013  
EXC014  
EXC015  
EXC016  
EXC017  
EXC018  
EXC019  
EXC020  
EXC021  
EXC022  
EXC023  
EXC024  
EXC025  
EXC026  
EXC027  
EXC028  
EXC029

```

FUNCTION EFORCE(I)
C THIS ROUTINE CALCULATES THE DEVICE FORCES IN DIRECTION I
C USING THE NORMAL DRAG APPROXIMATION FOR IN-LINE DEVICES
COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
1PJUNCS,PCAB,PCABE,PCABO,RCA60,THETA,PJUNCO
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,
1CDCAB,DCAB,FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,
2OFLG,NIR,THETAS,THETA,COMP,THETAB,NJUNC,RHO,TEST,
3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVCPT,
4WCAB,IDEV,ICHECK,NDEV,NDATC
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44)
1)
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22)
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCA60(3,51,22)
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22)
DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14)
DIMENSION ZVEL(25),VELZ(25),LCICAB(22),EXPCAB(22),ZJUNC(22)
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000)
DIMENSION ICHECK(44)
DIMENSION WTEL(3),VNORM(3),PSPACE(3)
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
INTEGER PATH
REAL IR,IRS
C CALCULATE THE WEIGHT VECTOR OF A DEVICE
WTEL(1)=0.
WTEL(2)=0.
WTEL(3)=DATA(6)
C CHECK TO SEE IF CURRENT OR NO CURRENT
JUM=JUMP+1
GO TO(1,2),JUM
C GET HERE IF NO CURRENT
1 EFORCE = WTEL(1)
RETURN
C GET HERE IF CURRENT
C CALCULATE LOCATION OF DEVICE IN SPACE
2 DO 3 KK=1,3
K=KK
3 PSPACE(K)=SPACE(K)
C CHECK IF DEVICE IS IN-LINE OR FREE
IJMP=DATA(4)
GO TO (5,4,5,4),IJMP
C GET HERE IF FREE TYPE DEVICE -- CALCULATE MAGNITUDE OF THE CURRENT
4 VMAG=SQRT(VELOC(1,PSPACE)**2 + VELOC(2,PSPACE)**2 + VELOC(3,PSPACE
1)**2 )

```

```

EF0001
EF0002
EF0003
EF0004
EF0005
EF0006
EF0007
EF0008
EF0009
EF0010
EF0011
EF0012
EF0013
EF0014
EF0015
EF0016
EF0017
EF0018
EF0019
EF0020
EF0021
EF0022
EF0023
EF0024
EF0025
EF0026
EF0027
EF0028
EF0029
EF0030
EF0031
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EF0038
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EF0040
EF0041
EF0042
EF0043
EF0044
EF0045
EF0046
EF0047
EF0048
EF0049
EF0050
EF0051
EF0052
EF0053
EF0054
EF0055
EF0056
EF0057
EF0058
EF0059

```



```
C CALCULATE THE FORCE ON THE FREE DEVICE
C
  EFORCE = WTEL(I)+(RHO/2.)*DATA(7)*DATA(8)*VMAG*VELOC(I,PSPACE)
  RETURN
C
C GET HERE IF IN-LINE DEVICE
C CALCULATE THE TANGENTIAL PROJECTION OF THE CURRENT ON THE DEVICE
C TANG(I) EVALUATES THE UNIT TANGENT TO A CABLE AT ANY POINT
C
  5 VPROJ=0.
  DO 6 KK=1,3
    K=KK
  6 VPROJ=VPROJ + VELOC(K,PSPACE)*TANG(K)
C
C CALCULATE THE NORMAL COMPONENT OF THE CURRENT AND ITS MAGNITUDE
C
  DO 7 KK=1,3
    K=KK
  7 VNORM(K)=VELOC(K,PSPACE)-VPROJ*TANG(K)
  VNORM=SQRT(VNORM(1)**2 + VNORM(2)**2 + VNORM(3)**2)
C
C CALCULATE THE FORCE ON THE IN-LINE DEVICE
C
  EFORCE=WTEL(I)+(RHO/2.)*DATA(7)*((DATA(8)/12.)*DATA(9)*VNORM
1 *VNORM(I)
  RETURN
  END
```

```
EF0060
EF0061
EF0062
EF0063
EF0064
EF0065
EF0066
EF0067
EF0068
EF0069
EF0070
EF0071
EF0072
EF0073
EF0074
EF0075
EF0076
EF0077
EF0078
EF0079
EF0080
EF0081
EF0082
EF0083
EF0084
EF0085
EF0086
```

```

      FUNCTION CFORCE (I,M,N)
C
C THIS ROUTINE CALCULATES THE FORCE/LENGTH IN DIRECTION I AT NODE M
C ON CABLE N USING THE NORMAL DRAG FORCE APPROXIMATION
C
      COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
      1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,
      1CDCAB,DCAB,FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,
      2OFLG,NIK,THETAS,THETAE,COMPJ,THETAB,NJUNC,RHO,TEST,
      3NVSEG,ZVEL,ZELZ(25),ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,
      4WCAB,IDEV,ICHECK,NDEV,NDATC
      DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44)
      1)
      DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22)
      DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22)
      DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22)
      DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14)
      DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22)
      DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000)
      DIMENSION ICHECK(44)
      DIMENSION WTCAB(3),VNORM(3),PSPACE(3)
      INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,CFLG
      INTEGER PATH
      REAL IR,IRS
C
C CALCULATE THE WEIGHT/LENGTH VECTOR
C
      WTCAB(1)=0.
      WTCAB(2)=0.
      WTCAB(3)=WCAB(N)
C
C CHECK TO SEE IF CURRENT OR NO CURRENT
C
      JUM=JUMP+1
      GO TO (1,2),JUM
C
C GET HERE IF NO CURRENT
C
      1 CFORCE=WTCAB(1)
      RETURN
C
C GET HERE IF CURRENT
C CALCULATE LOCATION OF NODE IN SPACE
C
      2 DO 3 K=1,3
      3 PSPACE(K)=PCAB(K,M,N)
C
C CALCULATE THE TANGENTIAL PROJECTION OF THE CURRENT ON THE CABLE
C
      VPROJ=0.
      DO 4 KK=1,3
      K=KK
      4 VPROJ=VPROJ + VELOC(K,PSPACE) * RCAB(K,M,N) / TCAB(M,N)
C
C CALCULATE THE NORMAL COMPONENT OF THE CURRENT AND ITS MAGNITUDE
C
      DO 5 KK=1,3
      K=KK

```

CF0001  
CF0002  
CF0003  
CF0004  
CF0005  
CF0006  
CF0007  
CF0008  
CF0009  
CF0010  
CF0011  
CF0012  
CF0013  
CF0014  
CF0015  
CF0016  
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CF0021  
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CF0023  
CF0024  
CF0025  
CF0026  
CF0027  
CF0028  
CF0029  
CF0030  
CF0031  
CF0032  
CF0033  
CF0034  
CF0035  
CF0036  
CF0037  
CF0038  
CF0039  
CF0040  
CF0041  
CF0042  
CF0043  
CF0044  
CF0045  
CF0046  
CF0047  
CF0048  
CF0049  
CF0050  
CF0051  
CF0052  
CF0053  
CF0054  
CF0055  
CF0056  
CF0057  
CF0058  
CF0059

```

5 VNORM(K)= VELOC(K,PSPACE) - VPROJ * RCAB(K,M,N) / TCAB(M,N)
  VNORM = SQRT(VNORM(1)**2 + VNORM(2)**2 + VNORM(3)**2 )
C
C CALCULATE THE FORCE/LENGTH
C
  CFORCE=WCAB(1)+(RHO/2.)*CDCAB(N)*(DCAB(N)/12.)*EXCAB(M,N)*VNORM
1 *VNORM(1)
  RETURN
  END

```

CF0060  
CF0061  
CF0062  
CF0063  
CF0064  
CF0065  
CF0066  
CF0067  
CF0068

```

      FUNCTION SPACE(I)
C
C THIS ROUTINE CALCULATES THE LOCATION IN SPACE
C OF ANY POINT ON THE ARRAY
C
  COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
  COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,
1CDCAB,DCAB,FATE,NANC,ANJUNC,IRLAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,
2OFLG,NIR,THETAS,THETA,COMP,THETAB,ANJUNC,RHO,TEST,
3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,
4WCAB,IDEV,ICHECK,NDEV,NDATC
  DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44)
1)
  DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22)
  DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22)
  DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22)
  DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14)
  DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22)
  DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000)
  DIMENSION ICHECK(44)
  INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
  INTEGER PATH
  REAL IR,IRS
  IF(DATA(2).EQ.TLST(3)) GO TO 1
  IF(DATA(2).EQ.TLST(4)) GO TO 2
C
C GET HERE IF JUNCTION POINT
C
  1 K=DATA(3)
  SPACE = PJUNC(I,K)
  RETURN
C
C GET HERE IF POINT ON A CABLE
C
  2 N=DATA(3)
  M= (DATA(10)/H(N)) +1
C
C CALCULATE DISTANCE, SIGMA, OF POINT FROM NODE M
C
  SIGMA = DATA(10) - (M-1)*H(N)
C
C CALCULATE EXTRAPOLATION QUANTITIES
C
  EM=EXCAB(M,N)*RCAB(I,M,N)/TCAB(M,N)
  EM1=EXCAB(M+1,N)*RCAB(I,M+1,N)/TCAB(M+1,N)
C
C CALCULATE LOCATION
C
  SPACE = PCAB(I,M,N)+EM*SIGMA+((EM1-EM)/H(N))*(SIGMA**2)/2.
  RETURN
  END

```

SPA001  
SPA002  
SPA003  
SPA004  
SPA005  
SPA006  
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SPA008  
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SPA010  
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SPA043  
SPA044  
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SPA046  
SPA047  
SPA048  
SPA049  
SPA050  
SPA051  
SPA052

FUNCTION VELOC(I,PSPACE)

VEL001

VEL002

VEL003

VEL004

VEL005

VEL006

VEL007

VEL008

VEL009

VEL010

VEL011

VEL012

VEL013

VEL014

VEL015

VEL016

VEL017

VEL018

VEL019

VEL020

VEL021

VEL022

VEL023

VEL024

VEL025

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VEL027

VEL028

VEL029

VEL030

VEL031

VEL032

VEL033

VEL034

VEL035

VEL036

VEL037

VEL038

VEL039

VEL040

VEL041

VEL042

VEL043

VEL044

VEL045

VEL046

VEL047

VEL048

C THIS ROUTINE SPECIFIES THE I COMPONENT OF THE CURRENT FIELD  
C AT AN ARBITRARY POINT IN SPACE, PSPACE(I)

C  
COMMON /B1/ FEJUNC,IR,DELTA,DLTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,VEL006  
1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO  
COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATA,DATN,H,PJUNC,  
1CDCAB,DCAB,FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,VEL009  
2OFLG,NIR,THETAS,THETA,COMPO,THETAU,NJUNC,RHO,TEST,  
3NVSEG,ZVEL,VELZ,PIP,ECICAB,EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,  
4WCAB,IDEV,ICHECK,NDEV,NDATC  
DIMENSION FEJUNC(3,44),IR(3,44),IRS(3,44),TFJUNC(3,44),PJUNCO(3,44)VEL013  
1)  
DIMENSION FCAB(3,51,22),RCAB(3,51,22),PJUNCS(3,44),PCAB(3,51,22)VEL014  
DIMENSION PCABE(3,51,22),PCABO(3,51,22),RCABO(3,51,22)VEL015  
DIMENSION NNODE(22),ERJUNC(44),IRJUNC(44),DATA(10),DATN(10),H(22)VEL016  
DIMENSION PJUNC(3,44),CDCAB(22),DCAB(22),ANJUNC(44),TEST(14)VEL017  
DIMENSION ZVEL(25),VELZ(25),ECICAB(22),EXPCAB(22),ZJUNC(22)VEL018  
DIMENSION LJUNC(22),PATH(22),ICAB(22),WCAB(22),IDEV(1000)VEL019  
DIMENSION ICHECK(44)VEL020  
DIMENSION PSPACE(3)VEL021  
INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG  
INTEGER PATH  
REAL IR,IRS  
GO TO (10,10,30),I  
10 Z=PSPACE(3)  
DO 11 KK=1,NVSEG  
K=KK  
IF(Z.GT.ZVEL(K)) GO TO 11  
GO TO 12  
11 CONTINUE  
VFPS=(1.6878)\*VELZ(K)  
GO TO 14  
12 IF(K.NE.1) GO TO 13  
VFPS=(1.6878)\*VELZ(K)  
GO TO 14  
13 SIGMA=Z-ZVEL(K-1)  
SLOPE=(VELZ(K)-VELZ(K-1))/(ZVEL(K)-ZVEL(K-1))  
VFPS=(1.6878)\*(VELZ(K-1)+SLOPE\*SIGMA)  
14 GO TO (21,22),I  
21 VELOC=VFPS\*COS(THETA\*PIP)  
RETURN  
22 VELOC=VFPS\*SIN(THETA\*PIP)  
RETURN  
30 VELOC=0.  
RETURN  
END

**END**

**FILMED**

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**DTIC**